CIVIL ENGINEERING

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See article by Carl B. Jansen

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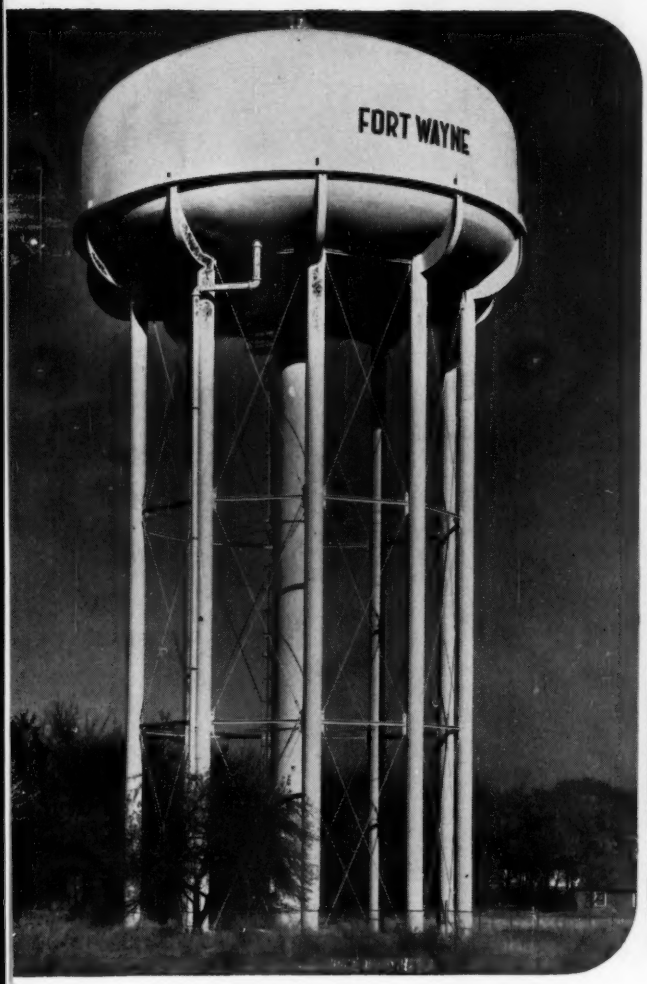

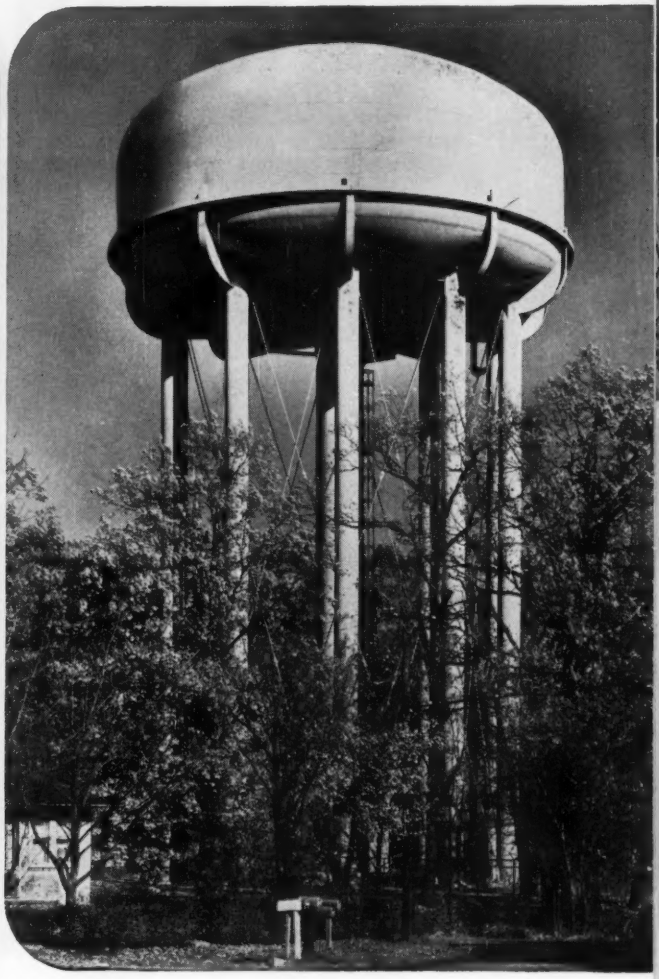

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CIVIL ENGINEERING, February 1956. Vol. 26, No. 2. Published monthly by the American Society of Civil Engineers. Publication office 20th and Northampton Streets, Easton, Pa. Editorial and advertising departments at ASCE Headquarters, 33 West 39th St., New York 18, N.Y. Entered as second class matter September 23, 1930, at the Post Office, Easton, Pa., under Act of August 24, 1912, and accepted for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized on July 5, 1918.

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CIVIL ENGINEERING

FEBRUARY 1956
VOL. 26 • NO. 2

THE MAGAZINE OF ENGINEERED CONSTRUCTION

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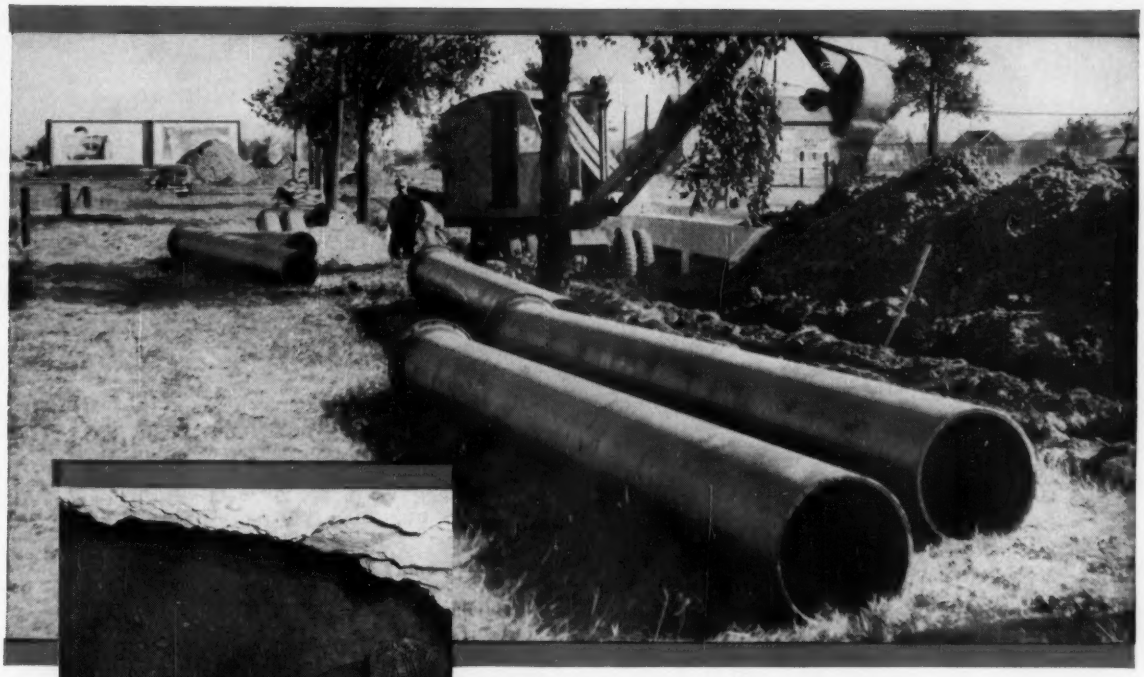

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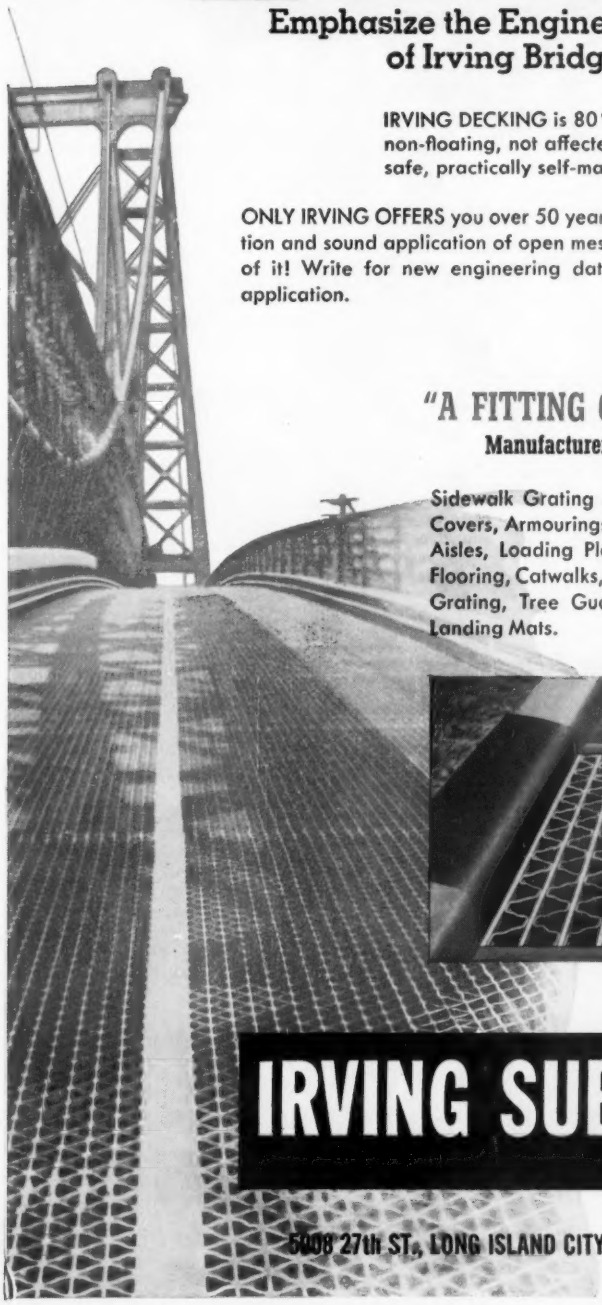

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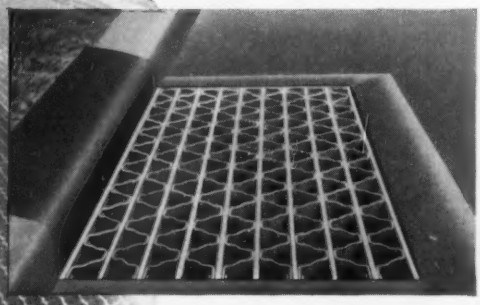

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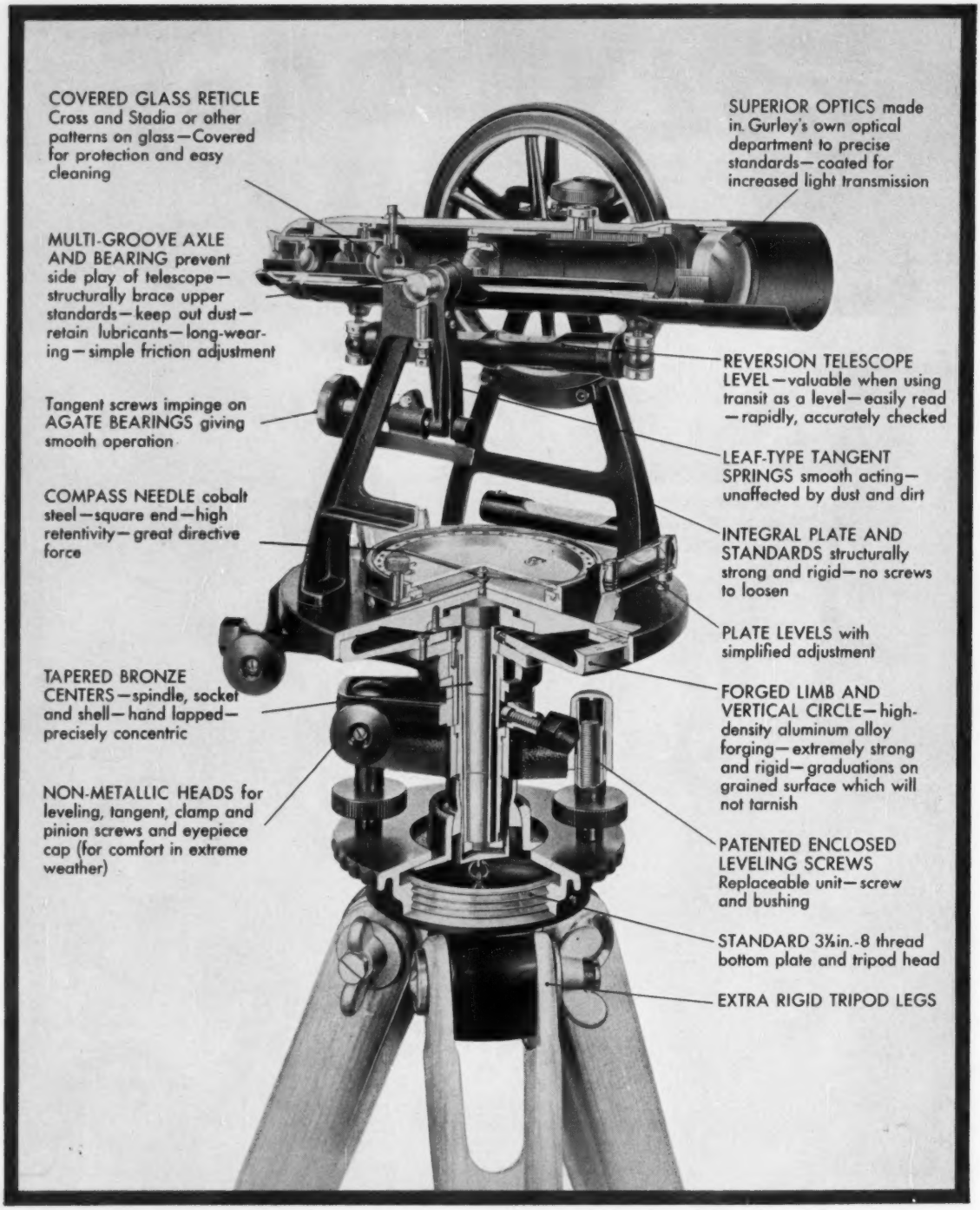
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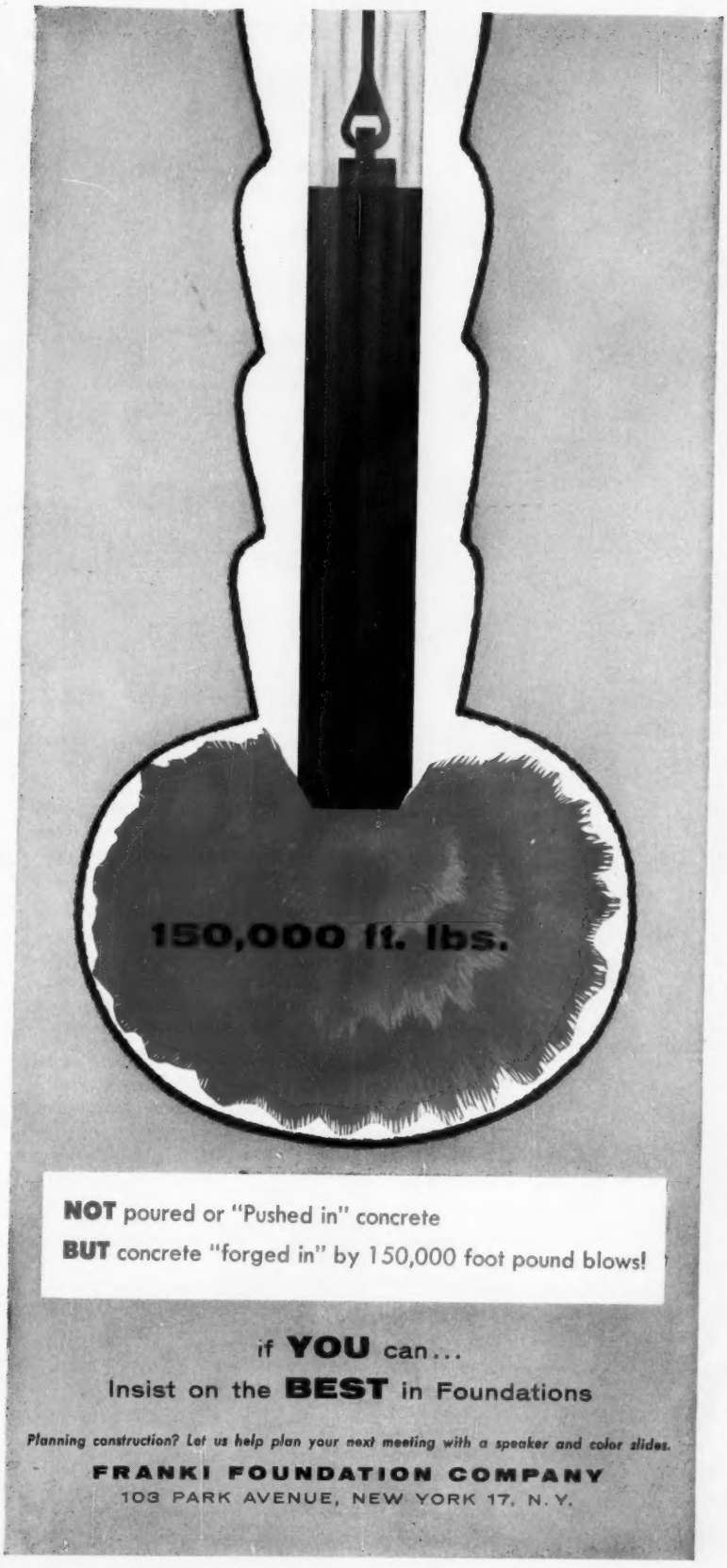
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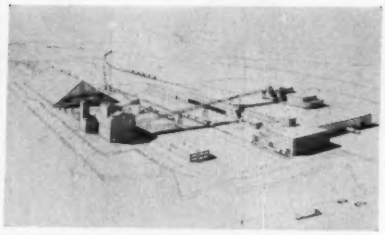

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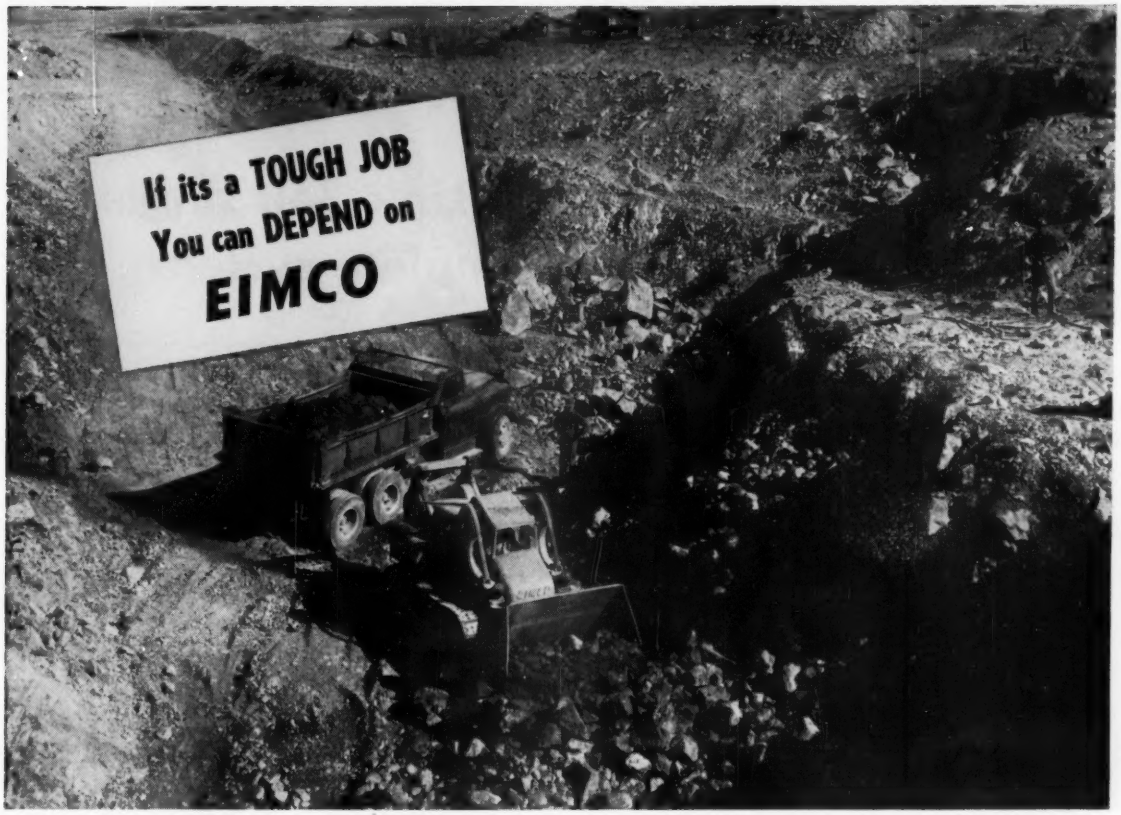

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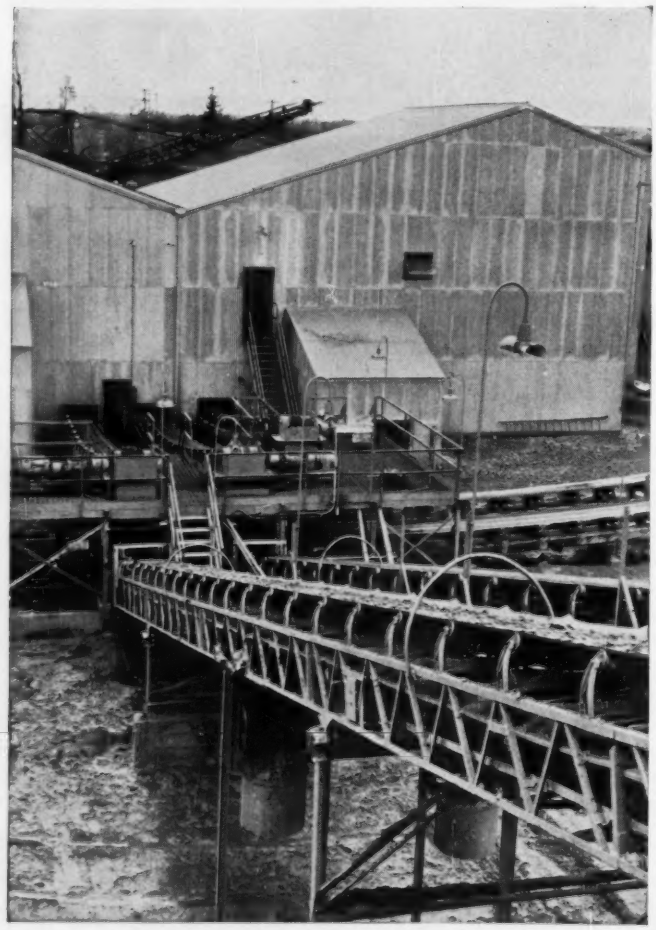

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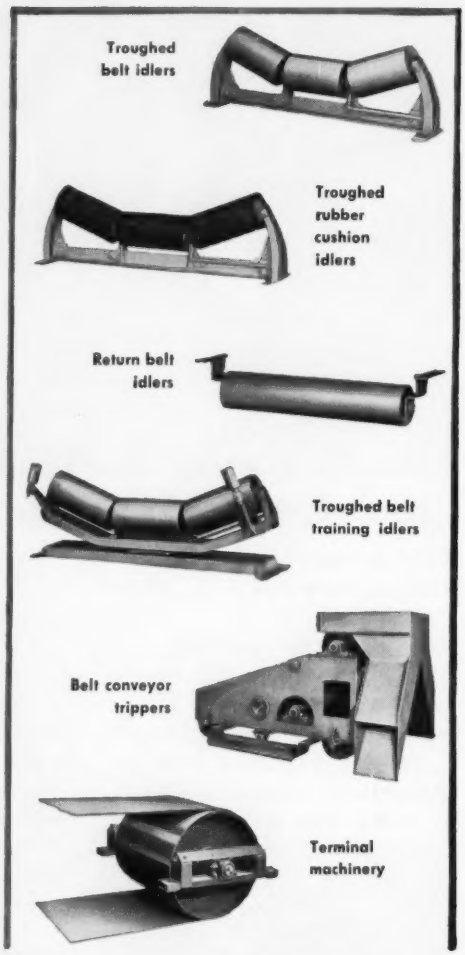

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How to CUT CLEARING COSTS

To help you clear land faster and cheaper, here are NEW IDEAS developed by clearing specialist Wade Lahar Construction Co. These "tricks" will help Lahar and their 22 International tractors finish a 23,500-acre job at Buford Dam 7 months ahead of an 18-month schedule.

One pass levels 18-inch trees—Where clearing to ground level is your primary job, Contractor Lahar recommends a big International tractor and V-shaped cutter. The cutter shown was designed and built by Herman Hackler, project manager, at Lahar's home plant in Mountain Home, Arkansas. Four 200 hp International TD-24's, so equipped, are handling most of the Buford Dam reservoir clearing near Atlanta, Georgia. In typical operation, they cut over so much land that 18 other International tractors are

1-to-5 slopes, 1,300 acres per month—Your TD-24 will efficiently clear trees from steep grades as well as from level ground. Here's what Herman Hackler, project manager for Lahar on the $1,611,560 contract, says about this big 200 hp, 8 mph crawler: "TD-24's high-low steering range keeps cutter against the tree until it falls, even on steepest slopes. This factor, plus the "24's" great power, excellent traction, and over-all balance, is letting us crawler-cut 99% of our Buford Dam job, despite slopes averaging 1-to-5, and, in some places, 1-to-4. Our fleet of *22 International tractors*—11 TD-24's (four of them with cutters), six TD-18's, three TD-14's, and two TD-9's—clears and rakes 1,300 acres per month. This production, in our opinion, could not be exceeded by any other make of tractor!"

Burn, turn with one tractor—On big jobs, Mr. Lahar suggests use of one medium-sized tractor to handle burning of brush piles. This leaves bigger machines free for production work. Note how clear the raked ground is behind tractor. When Lahar's job is done, some 14,000 acres will be completely cleared; about 9,400 acres partly cleared, with some trees left standing in the water to benefit future water life.

Team decking boosts output—Where terrain permits, three to six of Lahar's 22 IH crawlers team to rake and pile the cut brush and trees. This gives two advantages . . . (1) rakes, by catching both ends of fallen trees and brush, pick up material lying between tractors which normally would require separate pass . . . (2) one pass per team is all that's needed to provide a clean swath.

kept busy decking and burning. One pass of their 13-ft long, 14-ft wide blade slices saw-like through brush, pine, and mixed hardwoods up to 18 inches in diameter. For scattered trees up to 12 inches in diameter, a similar though smaller cutter is used on a 66 dhp International TD-14A. Both TD-24 and TD-14 have a canopy of 2 and 2½-inch pipe. This protects operator and machine. Entire canopy and cutter assembly pins to regular A-frame . . . can be quickly detached and interchanged with standard or other special blades.

Blade "saws" larger trees—If your clearing work involves trees larger than 18 inches, here's another idea from Wade Lahar Construction Co. Using same mild-steel cutter blade as on smaller trees, have TD-24 operator "see-saw" back and forth a few times to cut the trunk. Just a few seconds' work with the 64,000-lb TD-24 will topple the tree.

Careful in-the-field maintenance boosts output, too. Left, mechanic uses compressed air to blow dirt and leaves from TD-24 radiator core. Right, special steel tooth, 2½ ft long with 18-inch overhang, is welded to TD-24 blade. Four teeth and top blade extension are used per raking tractor.

Winches logs from swamp—Clearing from marshy areas may present you with quite a problem too. Wade Lahar Construction Co does this work, 1% of their 23,500-acre Corps of Engineer job, with chain saw crews and winch-equipped TD-9 and TD-18 crawlers. After winching in, tractors skid timber to central area.

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makes every load a pay load

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A machine size for every job . . . see your nearest INTERNATIONAL INDUSTRIAL POWER DISTRIBUTOR for details.

PAYSCRAPERS
13 yds. and 18½ yds.

CRAWLER TRACTORS
8 Models . . 40 to 200 hp

DIESEL, GAS ENGINES
18 Models. 16½ to 200 hp

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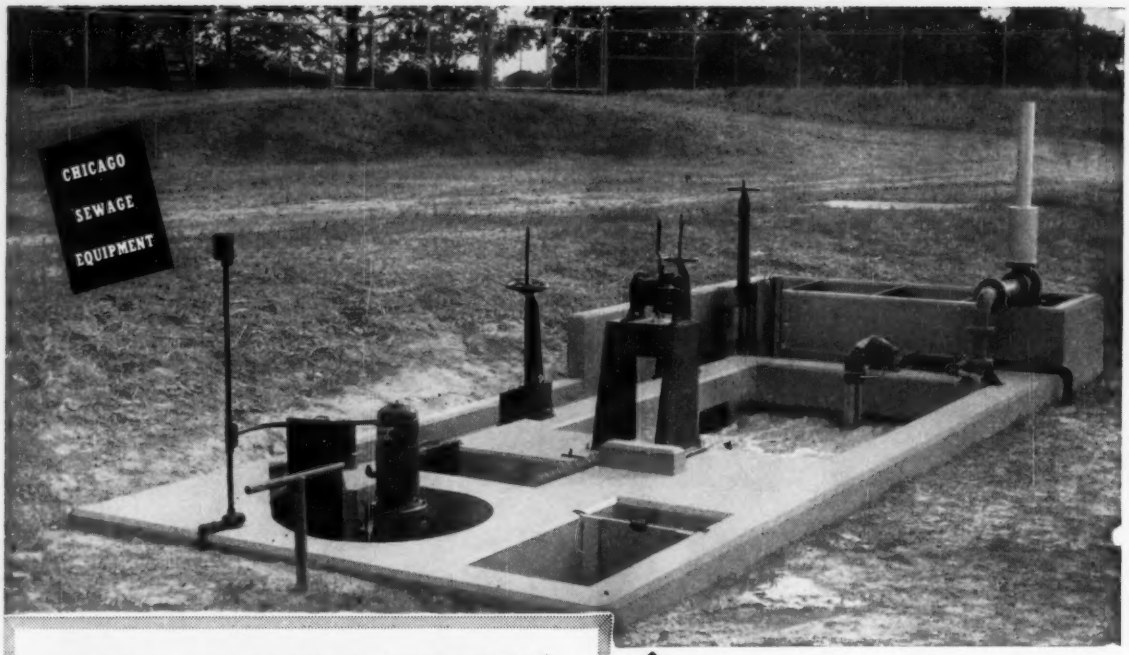
6 Models . . . 9 to 59 dbp

ALSO: International Drott Loaders . . International Scrapers, Bottom-Dump Wagons . . . International Superior Pipe-Boom Tractors . . . and International Trucks.



Aer-Degritter and Comminutor installation, Mayfield, Kentucky. Design flow 1.5 M.G.D. Russell, Axon & Associates, Engineers.

AER-DEGRITTER*

Air Controlled Settling Velocities Independent of Flow

The Aer-Degritter* removes grit and sand from sewage through the use of air to effect a controlled velocity of the sewage in the grit tank. The method provides a quiescent zone beneath the air diffusion media to effect a selective deposition of clean grit without organics. There is no need for separate grit washing tanks. Washing and deposition are effected in a single tank.

The principle of air controlled velocities was first demonstrated in sewage treatment plants designed by the office of Charles H. Hurd, Consulting Engineer. The Hurd method, using diffuser plates located behind the hopper, was an improvement over the then practiced means of controlling grit tank velocities. The Aer-Degritter* using diffuser tubes located directly above the hopper is, in turn, an improvement on the Hurd method.

POINTS OF SUPERIORITY OF THE AER-DEGRITTER*

1. Relative location of grit hopper and air diffusers. In the Aer-Degritter* the diffusers are elevated above the tank floor and the grit hopper is directly beneath the air diffusers. This permits greater flexibility of control of tank bottom velocities regardless of volume of sewage flow. It is these bottom velocities that control the deposition of clean grit and fine sand without also depositing organic material. Tests made on grit removed by Aer-Degritters* have consistently shown less than 0.05% putrescibles.

2. The equipment used to introduce air to the sewage. The use of Swing Diffusers and Precision Diffuser Tubes permits easy access to the grit hopper and cleaning of the diffuser media without taking the tank out of service.

*The application of the equipment, as well as the equipment itself is covered by U.S. Patents No. 2,532,457, No. 2,144,385, No. 2,328,655 and No. 2,555,201.

OVER 140 AER-DEGRITTERS IN* OPERATION IN LARGE AND SMALL PLANTS

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Subsidiary of Food Machinery and Chemical Corporation

SEWAGE EQUIPMENT DIVISION

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Flush Kleen ®, Scru-Peller ®, Plunger, Horizontal and Vertical Non-Clogs Water Seal Pumping Units, Samplers . . . Swing Diffusers, Stationary Diffusers, Mechanical Aerators, Combination Aerator-Clarifiers, Barminutor ®, Comminutors.

Write to Department G for Engineering Data

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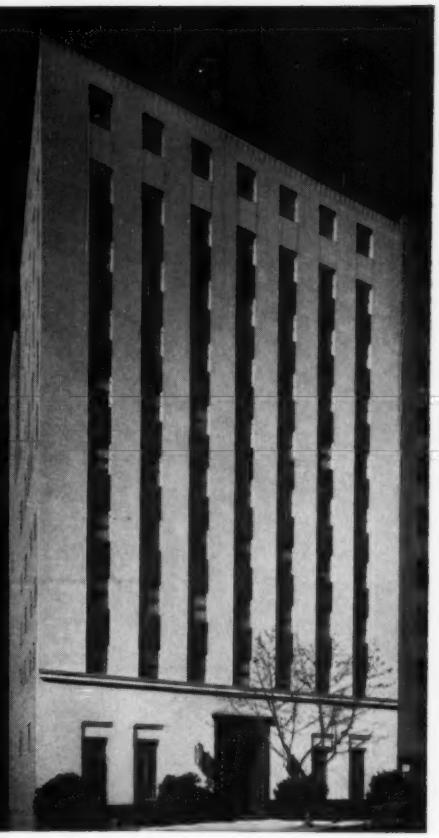
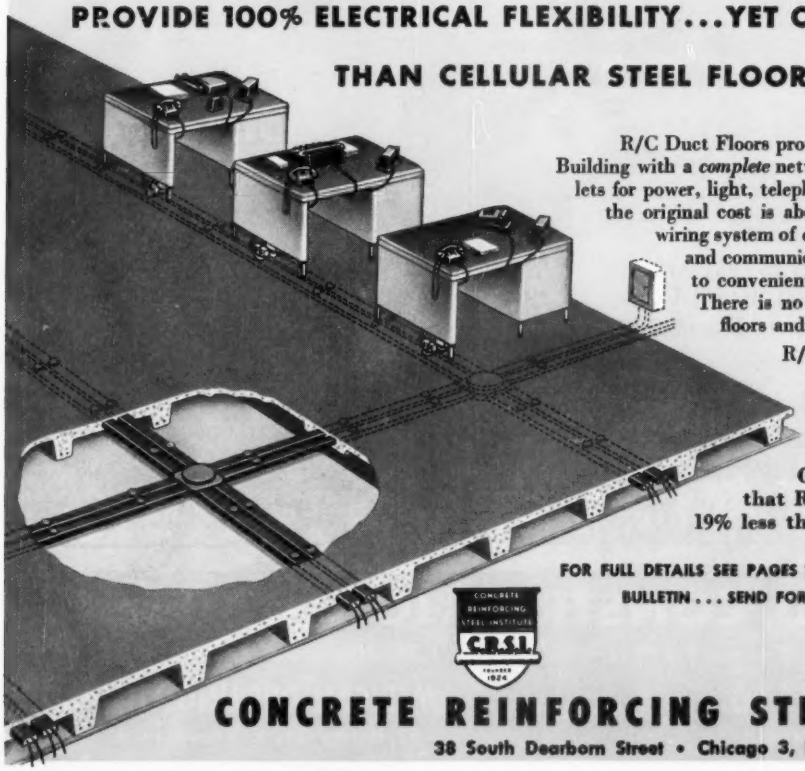
low cost R/C DUCT FLOORS

(ELECTRIFIED CONCRETE JOIST FLOORS)



THE EDITORS BUILDING, WASHINGTON, D. C.
Leon Chatelain, Jr., Architect
Beall & LeMay, Structural Engineers
John McShain, Inc., General Contractors

PROVIDE 100% ELECTRICAL FLEXIBILITY...YET COST MUCH LESS THAN CELLULAR STEEL FLOORS



R/C Duct Floors provide tenants of the new Editors Building with a *complete* network of underfloor electrical outlets for power, light, telephone, and intercom systems. Yet the original cost is about the same as a conventional wiring system of equal capacity. Outlets for power and communications systems can be connected to convenient risers in a matter of minutes. There is no ripping up or drilling through floors and ducts.

R/C Duct Floors consist of *standard* steel electrical distribution ducts set in the *structural* slab of reinforced concrete joist floors . . . *no expensive fill or topping is needed.*

Cost comparisons showed that R/C Duct Floors cost about 19% less than cellular steel floors!

FOR FULL DETAILS SEE PAGES 10-11 IN NEW 16-PAGE BULLETIN . . . SEND FOR YOUR COPY!

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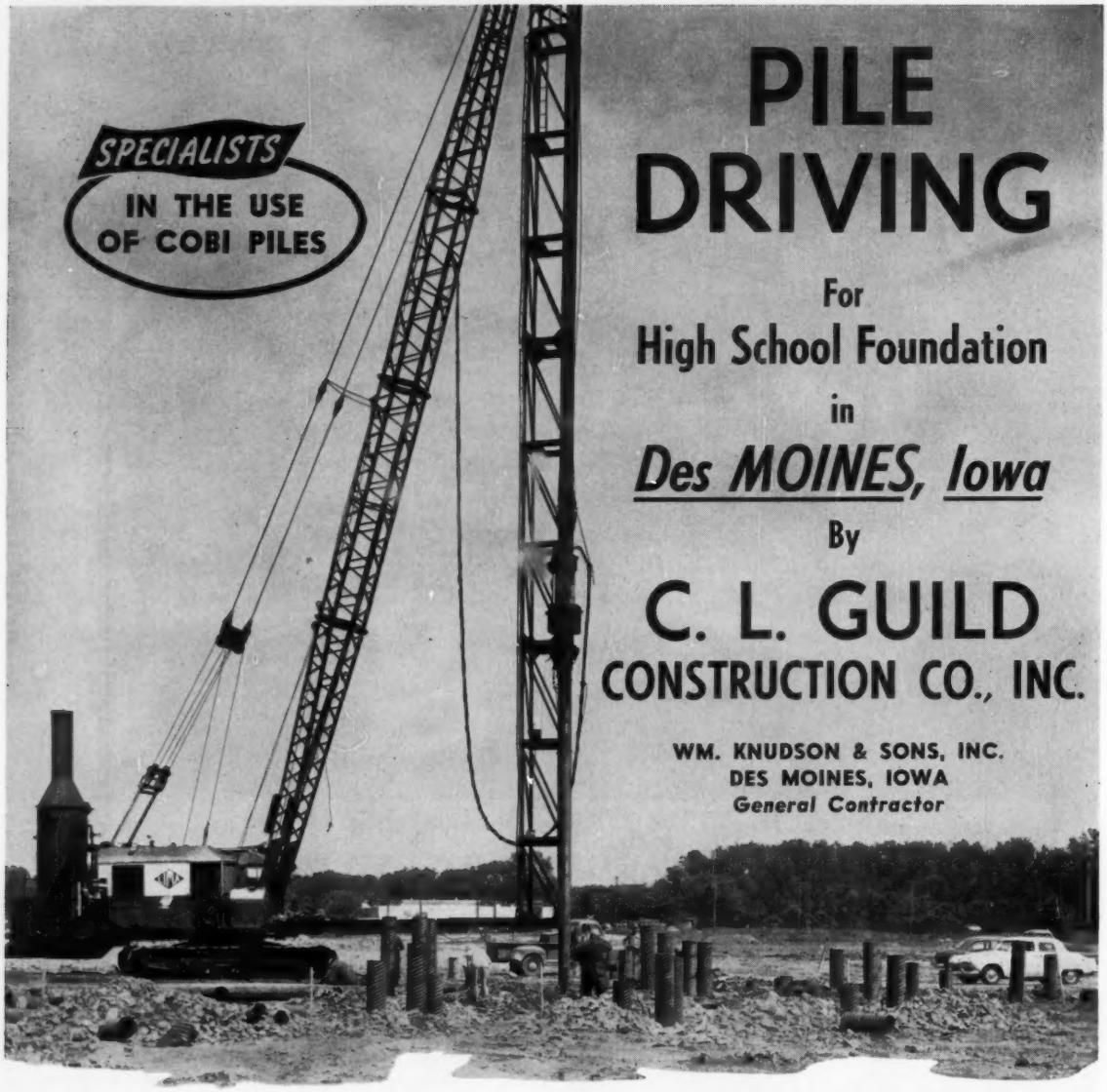

PILE DRIVING

For
High School Foundation
in
Des MOINES, Iowa
By

C. L. GUILD CONSTRUCTION CO., INC.

WM. KNUDSON & SONS, INC.
DES MOINES, IOWA
General Contractor

IN a trip across the country in 1955 you'd find C. L. GUILD Construction Co., Inc. driving piles from Maine to Florida to Texas—and North.

These projects specified all types of piling — but most were COBI CAST-IN-PLACE Piles, because Guild is a specialist in driving cast-in-place piles and uses COBI PILES exclusively. There are seven reasons why Cobi Cast-in-Place piles are best. Write us for these reasons,—and specify COBI CAST-IN-PLACE Piles.

TO CONTRACTORS

If you are bidding a job that calls for piles, ask C. L. Guild for an estimate on any type of pile—anywhere.

C. L. Guild Construction Co., Inc. is a national organization — specialists in driving all types of piling.

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AMERICAN DRILLING COMPANY
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75,000-gal. Horton elevated water tank at Gerber Products, Inc., Rochester, N. Y.

UNIQUE HORTON WATER TANK AT GERBER'S

It would be hard to measure the publicity value of the special Horton® water tank shown at the left, built for Gerber Products Inc. at Rochester, New York. A replica of the nationally known Gerber Baby Foods jar, it towers above the surrounding area.

This unique water tank provides a dependable, gravity pressure water supply that is always available—with the automatic plant sprinkler system, it provides maximum fire protection.

Investment wise, the water tank and plant sprinkler system will pay for themselves in approximately five years through reduced insurance premiums.

Write our nearest office for information on Horton elevated tanks of standard or unique design.

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San Francisco • Seattle • Tulsa
Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY *and* GREENVILLE, PA.

NEWS OF ENGINEERS

Jewell M. Garrelts, Renwick professor of civil engineering at Columbia University, was honored by the University's Society of Older Graduates with one of its "Great Teacher Awards" at its 46th annual dinner meeting held at the Columbia University Club, New York City, on January 11. A noted bridge engineer, Professor Garrelts worked on the design of the Rainbow Bridge over Niagara Falls. He is currently serving ASCE as Director.

Harry R. Mason, of Amsterdam, N.Y., has been appointed county highway superintendent of Montgomery County, New York. Mr. Mason has been acting superintendent since 1951.

John E. O'Leary, for the past 26 years general sales manager of the Pittsburgh-Des Moines Steel Co., Neville Island-Pittsburgh, Pa., retired recently. Mr. O'Leary has been associated with the company for 45 years and is widely known in the municipal water works and general construction fields.

Ferdinand N. Menefee, professor of engineering mechanics at the University of Michigan, Ann Arbor, is convalescing from a recent illness. He is on terminal leave from teaching after 45 years of service.

Lester C. Rogers, president of Bates & Rogers Construction Corporation, Chicago, Ill., was recently elected a director of the Metal & Thermit Corp. Long and prominently identified with the construction industry, Mr. Rogers will be inducted as vice-president of the Associated General Contractors of America at its forthcoming annual meeting.

Lester C. Rogers

Samuel T. Larsen has returned to his home in Denver, Colo., from Iraq, where he spent two years as an engineer with the International Cooperation Administration mission there. As general engineer and assistant to the Iraq Development Board, Mr. Larsen's work was largely concerned with water resources and flood control projects. He plans to return to the Bureau of Reclamations in Denver, with which he has been connected for seventeen years.

Nicholas V. Feodoroff, associate professor of civil engineering at Manhattan College, has been reelected chairman of the Section of Mathematics and Engineering of the New York Academy of Sciences for the year 1956. He has also been appointed by the president of the New York Academy of Sciences to serve as a member of the Committee on Fellows and Honorary Members for 1956.

John W. Hubler, consulting engineer for Macomber, Inc., Canton, Ohio, was recently appointed to the newly created post of vice-president. He will be responsible for designing, detailing and shop billing, both in the Canton office and in the field organization throughout the country. He will also have charge of research engineering.

John J. Theobald, president of Queens College, Flushing, N.Y., has been appointed deputy mayor of the City of New York. In this non-political appointment, it is expected that Dr. Theobald, holder of a degree in civil engineering and a Ph.D. in political science from Columbia University, will contribute expert guidance to the municipal government. For his term of duty at City Hall, Dr. Theobald has been granted a sabbatical leave without pay for one year by the Board of Higher Education.

HIGH QUALITY HYDRANT

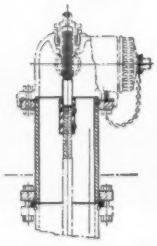
The R. D. Wood Standard Swivel Joint Hydrant with or without breakable flange and stem coupling

All Bronze Stuffing Box

Sound and simple in construction. It cannot rust or corrode. Hydrant operating thread can be greased or oiled by unscrewing one small plug.

Extension Piece

Can be inserted between hydrant head and barrel or between barrel and elbow. Installation does not require shutting off water supply.



R. D. WOOD

Public Ledger Building, Independence Square
Philadelphia 5, Pa.

Laurence B. Kuhns and **Boynton J. Fletcher** have been named assistant chief engineers of the Aluminum Company of America. Both men will also continue in their present positions—Mr. Kuhns as chief construction engineer and Mr. Fletcher as chief hydraulic engineer.

Herbert F. Darling, prominent civil engineer and past-president of the Buffalo Section, has been appointed to the Board of Overseers of Thayer School of Engineering at Dartmouth College, of which he is an alumnus.

Harish C. Mukerji, chief valuer, Calcutta Improvement Trust, Calcutta, India, was inducted as chairman of the Bengal Center of the Institution of Engineers (India) during the annual general meeting of the Institution on December 17.

Clare R. Van Orman, Corps of Engineers, Kansas City District, has been relieved of his duties in the Design Branch in order to devote full time to his basic assignment as assistant chief of the Engineering Division.

Paul C. Paris has been appointed instructor of mechanics at Lehigh University. He held a similar position for the past year at Lafayette College, Easton, Pa. Mr. Paris received his master of science degree from Lehigh recently and is a graduate of the University of Michigan, class of 1953.

Emory E. Johnson, of the department of civil engineering at South Dakota State College, was elected president of the South Dakota Society of Engineers and Architects, at its recent annual convention held in Rapid City, S. Dak.

James G. Johnstone is heading the new soils and engineering geology section of Geophoto Services, Denver, Colo., which has recently expanded its services to include this field. Formerly assistant professor of engineering geology and highway engineering at Purdue University, Mr. Johnstone has a wide background in engineering and soils investigations.

James G. Johnstone

Edward R. Stapley, dean emeritus of Oklahoma Agricultural and Mechanical College, Stillwater, Okla., was honored by alumni, faculty, students and friends in a day-long program at the close of 1955 for "his 30 years of service to the college, the state, and the engineering profession." He retired from the staff in September 1955 (September issue, page 22).

Walter K. Neubauer was recently appointed an associate member of O'Brien & Gere, consulting engineers of Syracuse, N.Y. Mr. Neubauer, who has been with the firm for the past two years, will head its department of water supply engineering. Mr. Neubauer is secretary-treasurer of the Syracuse Section.

Lewis P. Scott, of East Lansing, Mich., was honor guest recently at a luncheon given by the State Highway Department and Michigan staff of the Bureau of Public Roads upon his retirement after 32 years of service with the Bureau as Michigan district engineer. Mr. Scott played a large part in the development of Michigan's trunkline and county road system.

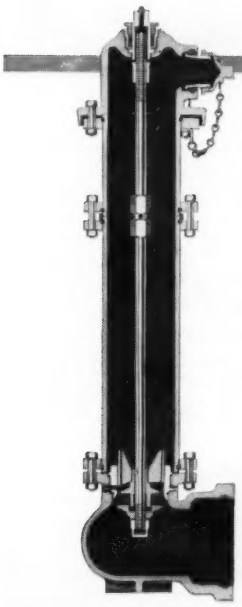
Frederick C. Lowy, consulting engineer of New York City, has opened a new office for the practice of engineering at 259 West 14th Street, N. Y. City. His associate consultants will include **Rudolph F. Schaefer,** in charge of tunnels and bridges, and **Malcolm S. Spelman,** in charge of specifications.

Charles O. Georgi has established a private civil engineering and land surveying practice in St. Paul, Minn. Until recently Mr. Georgi was in the civil engineering department of the University of Minnesota. He has also taught at Villanova University, and has been in the Navy Civil Engineer Corps on overseas construction.

(*Continued on page 25*)

AT LOWEST COST

The R. D. Wood Standard Swivel Joint Hydrant is designed to provide maximum strength and reliability at lowest possible cost. Internal friction, which can lower pressure, is reduced to the minimum, well below A.W.W.A. specifications. Changes of diameter are carefully rounded and nozzleways are scientifically tapered.



Breakable Flange and Stem Coupling

Available at slight additional cost are this specially designed flange in the standpipe and a frangible coupling in the hydrant stem. A heavy blow that would ordinarily break the hydrant will snap the ring in the flange and the coupling in the stem. Both can be replaced quickly and inexpensively. No digging is necessary.

Exterior views showing breakable swivel flange and head with steamer nozzle and two hose connections. Available with standard types of pipe connections—bell, *mechanical joint,* flange, universal or screw.

COMPANY

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If you are planning to build in an area that may possibly be affected by flood conditions, your best insurance is dependable foundation construction. While replacing stock and equipment as a result of flooding is certainly not a simple task, it is nothing compared to the repair or reconstruction cost of a complete building or plant.

For over half a century, we at Raymond have been specializing in all types of foundation work under every conceivable condition. In the recent storms in the Northeast, a number of structures resting on Raymond Piles were flooded. (One of these, the Stacey War Memorial Building in Trenton, is shown above). NONE OF THE BUILDINGS ON RAYMOND FOUNDATIONS IN ANY OF THE FLOOD AREAS WAS MOVED A FRACTION OF AN INCH, even though some of the surrounding structures were swept away.

We'll be happy to apply our experience to your foundation problems, whether they're large or small, routine or unusual. Remember, Raymond foundations are *permanent*.

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Branch Offices in Principal Cities AROUND THE WORLD FOUNDED 1901 *of the United States, Canada, Central and South America*

News of Engineers

(*Continued from page 23*)

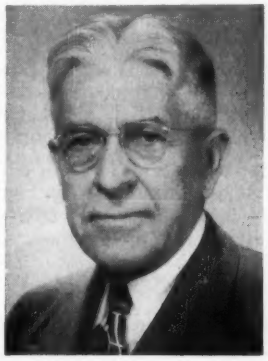
William F. Neal, of Towson, Md., became a partner in the firm of Whitman, Requardt & Associates, Baltimore consultants on January 1. Mr. Neal has been with the firm for the past twelve years, with the exception of three years as chief engineer of the Metropolitan District of Baltimore County. The other partners are **Ezra B. Whitman, Gustav J. Requardt, A. Russell Vollmer, Roy H. Ritter** and **Theodore W. Hacker.**

Gene M. Nordly, formerly on the civil engineering staff at the University of Colorado, has joined the faculty of Purdue University as associate professor of structural engineering, effective February 1.

Walter Babchuk has been appointed field engineer for the Los Angeles district of the American Institute of Steel Construction. His new duties will include contact with architects, engineers and public building officials regarding questions pertinent to the use and fabrication of structural steel.

John R. Anderson has taken over new duties as structural research engineer of the Los Angeles County Division of Building and Safety. Except for two years, Mr. Anderson has been in the Building Department since the end of the war, in which he served in the U. S. Navy. He was recalled to active duty in 1952 as assistant resident officer in charge of construction of the Marine Corps Base at Twenty-Nine Palms.

I. Cleveland Steele, prominent consulting engineer of Piedmont, Calif., and former Director of ASCE, was named one



I. Cleveland Steele

of the construction industry's "men of the year" at the Building Industry Conference Board's annual awards dinner held recently in San Francisco. He received the group's "Honorary Award." Mr. Steele was vice-president and chief engineer of the Pacific Gas & Electric Co. until his retirement in 1951 after 42 years of service. In consulting practice since 1951, Mr. Steele is one of three members of the board of consultants on the Sacramento Municipal Utilities District's proposed hydroelectric development on the Upper American River.

Robert Horton was recently appointed assistant director of commission staff operations for the Ohio River Valley Water Sanitation Commission. Mr. Horton joined the commission in 1949, following six years as a U. S. Army Sanitary Corps officer in Peru and San Salvador. He has acted as the Commission's expert witness at public hearings in connection with establishment of sewage-treatment requirements.

Paul L. Thomas, of Summit, N.J., has been promoted to deputy director of the Operation Services Department of the Port of New York Authority. Mr. Thomas, who has been executive assistant to the director of Operations Services for the past year, joined the company in January 1953 as supervisor of facilities planning in the Aviation Department. In his new position he will be responsible for developing, administering, and directing specific services for all Port Authority departments.

(*Continued on page 28*)

MAYO ALL-STEEL...

SINKING and HEAD FRAMES

Safe—Dependable—Designed right for the job. For your operation, depend on Mayo methods and skill based on over 25 years experience in America, Europe and South America. Write for Bulletin No. 20.

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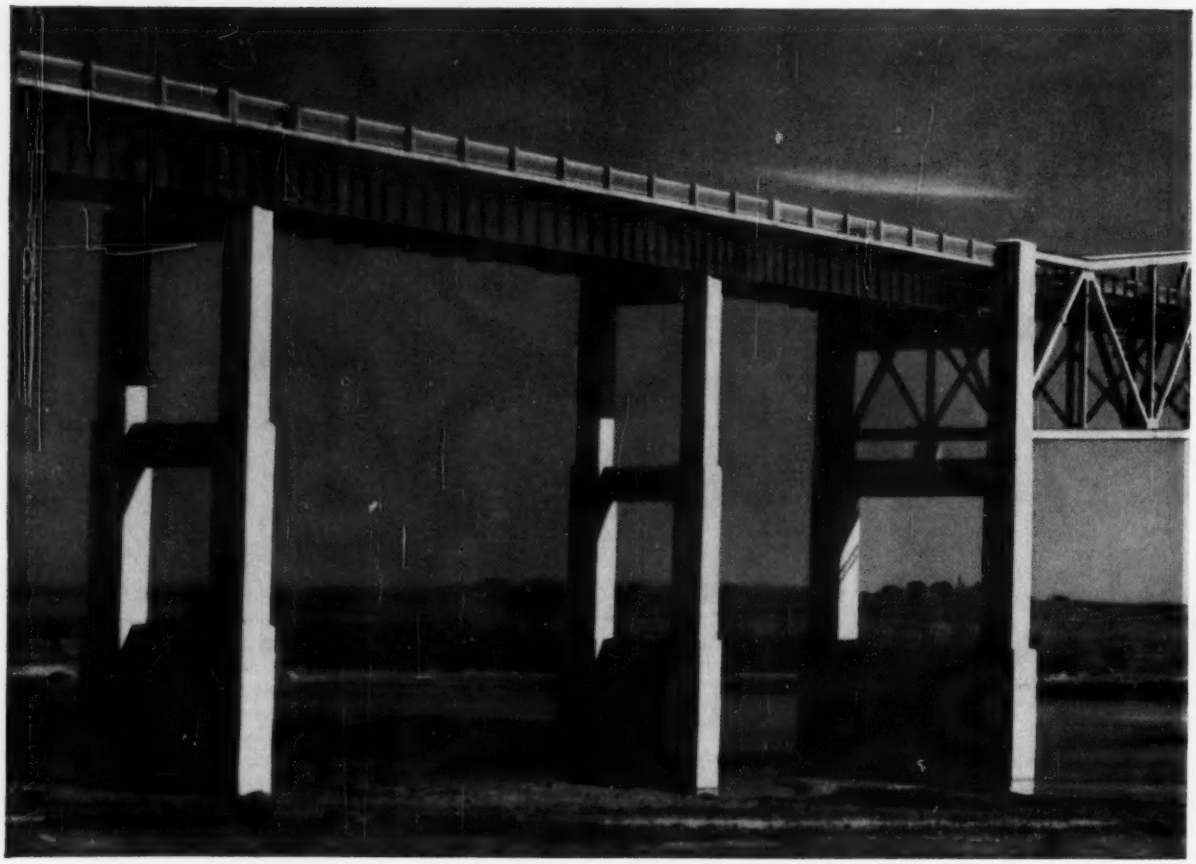
Saved- $250,000 - by using

THE recently completed Columbia River Bridge at Umatilla, Oregon, is another excellent example of the savings that can be realized by reducing weight of bridge construction by the proper use of USS High Strength Steels.

This 3,380 ft. double cantilever structure consists of two 600 ft. main spans, two 300 ft. anchor arms, and one 120 ft. central suspended span plus fifteen plate girder spans of 90 and 100 ft.

1,452 tons of USS TRI-TEN "E" Steel were used in the truss spans and 412 tons in the plate girder spans. This total of 1,864 tons of TRI-TEN "E" represents more than half of the steel involved in the superstructure. (Carbon structural steel was used in the remainder.)

The decision to use TRI-TEN "E" Steel in the most highly stressed members was predicated on comparative estimates of weight and costs for both carbon structural steel and High Strength Steel. As made by the Tudor Engineering Company, engineers and designers, these design comparisons showed that



USS HIGH STRENGTH STEELS

—the big step forward in bridge construction

USS TRI-TEN "E" Steel in superstructure

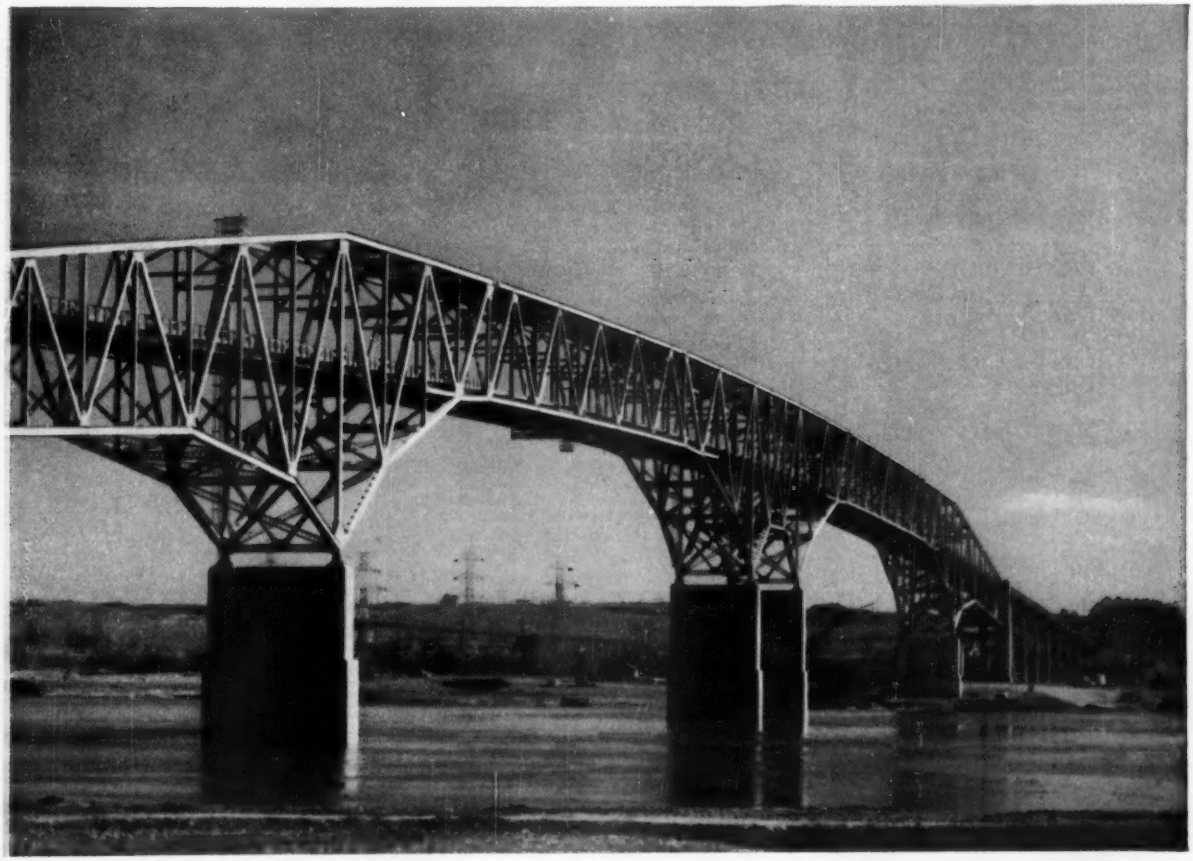
on the basis of cost installed, USS TRI-TEN "E" Steel used in place of carbon steel would result in a potential savings of 15% of the cost of the superstructure.

This saving of some $250,000 was made possible because of the weight saved by using TRI-TEN "E" Steel in lighter sections—which not only meant that a smaller tonnage of steel was required for the job but also materially reduced steel transportation costs.

And here's something to bear in mind. The substantial cost reduction made on this Umatilla Bridge by substituting High Strength Steel for carbon steel involves a bridge structure in which only slightly more than half the total steel tonnage used was of High Strength Steel.

For more information on our High Strength Bridge Steels, write to Room 5145, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

Owner — Umatilla County, Oregon. Designed and engineered by Tudor Engineering Company. Structural steel fabricated and erected by American Bridge Division, United States Steel.



UNITED STATES STEEL CORPORATION, PITTSBURGH • AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO • NATIONAL TUBE DIVISION, PITTSBURGH
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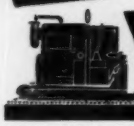
USS

UNITED STATES STEEL

McCARTHY DRILLS



McCARTHY TRENCH OR TUNNEL TYPE HORIZONTAL DRILL

DRILLS UNDER HIGHWAYS, RAILROADS, ETC.

A utility money-maker! Drills through rock or earth for drainage, conduit, pipe lines, etc., without breaking the surface. Drills 4" to 24" holes up to 180 ft. long in hardpan, compacted sand, gravel and shale formations. Send for Bulletin.

McCARTHY VERTICAL AUGER DRILLS

BLAST HOLE DRILLING MODEL 106-24

Drills dry holes 3" to 24" in diameter. For blasting jobs, prospecting, foundation boring, earth sampling, dewatering operations. Send for Bulletin No. M-100.

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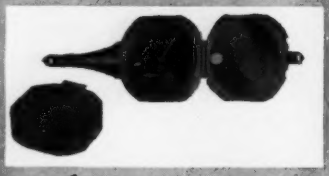

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News of Engineers

(*Continued from page 25*)

Walter L. Dickey (left), M. ASCE, takes over the presidency of the Structural Engineers Association of Northern California from Howard A. Schirmer, A.M. ASCE, at recent meeting in San Francisco, Mr. Dickey is civil and structural engineer for the Power Division of the Bechtel Corp., San Francisco.

Harry C. Sprague has been promoted to director of the design division of the Seventeenth Naval District located at the U.S. Naval Station, Kodiak, Alaska. He was connected with the U.S. Bureau of Reclamation at Ephrata, Wash., prior to leaving the States.

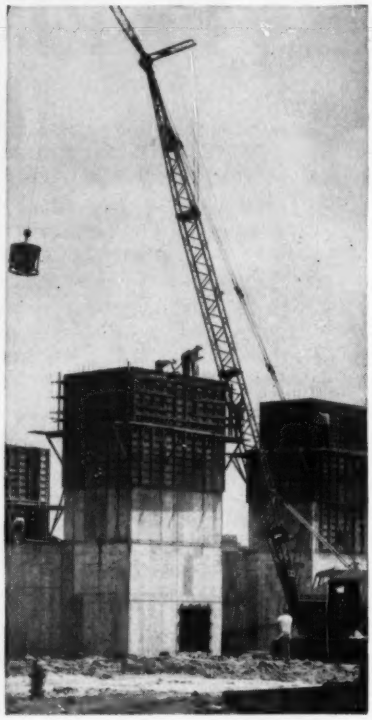
James C. Johnson, for the past four years district engineer for the Asphalt Institute at Oklahoma City, has joined the headquarters staff of the Institute in College Park, Md., as staff engineer. In his new duties he will work directly with the chief engineer on special problems in asphalt engineering and soil stabilization.

John P. H. Perry was recently elected consultant to the engineering firm of Seelye Stevenson Value & Knecht of New York City. Mr. Perry served two and one-half years as deputy to the Assistant Secretary of the U.S. Air Force in charge of air base construction all over the world, and for thirty years previously was vice-president and director of the Turner Construction Company of New York City.

Wilbur L. Sharp, rate engineer of the Portland General Electric Company, Portland, Ore., retired from active management of his department, effective December 31. Mr. Sharp will continue to serve the company in a consulting capacity. His home address is 1034 N. E. Prescott St., Portland 11.

David B. Steinman, eminent bridge engineer of New York City, has received the Marechal Caetano de Faria Medal from the Brazilian government, "in recognition of his professional achievements and, particularly, his notable engineering

Symons FIELD REPORT...



SYMONS FORMS USED ON TWA TEST CELLS ...

Five aircraft engine test cells, with exhaust and intake stacks 45 feet high, are being erected at Trans World Airlines' overhaul base at Mid-Continent International Airport, Kansas City, Mo.—the first cells of their kind in the United States.

These cells are on a concrete base, and 12,500 square feet of Symons Forms with Steel Cross Members were used for the 55,000 square feet of concrete forming required. Sharp Brothers Contracting Company, Kansas City was the general contractor.

TWA test cells are just one of many commercial, industrial, institutional and public works construction jobs for which Symons Forms are adaptable. Symons engineering staff gives complete service on the details of all forming jobs. Our salesmen are field-trained to give practical advice on form erection, pouring and stripping methods.

Symons Forms, Shores and Column Clamps may be rented with purchase option, all rentals to apply on purchase price. Symons Clamp & Mfg. Co., 4291 Diversey Ave., Dept. B6, Chicago 39, Ill.

In this unusual stripping procedure, panels are being removed by a worker seated in a bosun's chair suspended from a crane boom.

For More Information on FORMS—CLAMPS—SHORES. Write for Literature

contribution to the Republic of Brazil." The medal and diploma were presented to him at a special ceremony in his honor at the Brazilian Embassy in Washington, D.C.

Edwin G. Robbins, director of construction of Walter Kidde Constructors Inc., New York and Houston, was recently elected vice-president in charge of construction. A member of the company for 28 years, he has been director for the past eighteen months, and has supervised construction on a broad range of projects. **Frank L. Whitney** was also elected vice-president in charge of engineering.

Joseph P. Lawlor has been reelected to a second term as mayor of Ames, Iowa, where he is president of the General Filter Co. Mr. Lawlor has also recently been elected to serve another term as president of the Iowa Taxpayers Association with headquarters in Des Moines.

Donald F. Moran, formerly associated with the Pacific Fire Rating Bureau, Los Angeles, as structural engineer, has joined the firm of Quinton Engineers, Ltd., as chief structural engineer. His headquarters will be in Los Angeles. Recently Mr. Moran was also appointed a lecturer in engineering at the University of California.

Herbert E. Hudson, Jr., became associated with the firm of Hazen and Sawyer, New York City engineers, December 1. Mr. Hudson has been chief engineer of the Illinois State Water Survey, Urbana, Ill., since 1946. Earlier he worked with John R. Baylis in operation and research at the Chicago Experimental Filtration Plant and in design of the South District Filtration Plant in Chicago.

LeRoy K. Smith, for the past nine years chief engineer of the Texas Petroleum Co. of Venezuela, was recently appointed vice-president and construction manager of the E. J. Salvidge Construction Co., Youngstown, Ohio. Earlier, Mr. Smith spent 12 years in Central and South America with the Truscon Steel Division of the Republic Steel Corp.

Eugene L. Sembler, for the past several years assistant port engineer at Corpus Christi, Tex., has become Galveston Wharves' new engineer. He is a native of St. Joseph, Mo., and a graduate of the University of Texas.

J. George Thon was recently appointed to the position of chief civil engineer, power division, Bechtel Corp. of San Francisco. Prior to his new assignment, Mr. Thon was project engineer on the Pittsburg and Morro Bay steam electric plants which Bechtel is designing and constructing for the Pacific Gas & Electric Company.

New Publications

Coastal engineering . . . Availability of the proceedings of the Fifth Conference on Coastal Engineering—held at Grenoble, France, in September 1954—is announced by the Council on Wave Research of the Engineering Foundation. The 669-page volume is edited by J. W. Johnson, M. ASCE, professor of hydraulic engineering at the University of California. Copies, priced at $7.50 each, may be purchased from the Council on Wave Research, University of California Building 159, Richmond 4, Calif. Also available from the same source is the Proceedings of the First Conference on Ships and Waves—a 510 page compilation selling for $6.00.

Highway engineering . . . Hitherto unpublished papers—presented at the Highway Engineering Conference held at the University of Mississippi in February 1955—are now available in the Proceedings of the Conference. Among them are studies on "Foundation Stabilities," by Raymond F. Dawson, Director, ASCE; "Stabilization of Materials by Compaction," by W. J. Turnbull, M. ASCE, and Charles R. Foster, A.M. ASCE; and "Functions of Engineering Geology," by Karl Terzaghi, Hon. M. ASCE. The Proceedings may be obtained from the Department of Civil Engineering, University of Mississippi, University, Miss. The price is $2.00.

Pollution studies . . . As part of its research program in the field of waste-water reclamation and utilization, the California State Water Pollution Control Board contracted with the University of California for a field investigation to obtain information on (1) the extent and rate of travel of pollution with ground-water flow and (2) the use and methods of operating recharge wells as means of waste-water disposal and ground-water replenishment. The research was directed by Prof. Harold B. Gotaas, M. ASCE, director of the Sanitary Engineering Research Laboratory. The results of the investigation—conducted at the university's Engineering Field Station on the northeast shore of San Francisco Bay—are described in the Control Board's Publication No. 11. A limited number of copies are available upon request to the Board, Room 610, 721 Capitol Ave., Sacramento 14, Calif.

Lift Slab Method . . . Reference material prepared exclusively for the architect or engineer making first use of the Youtz-Slick Lift Slab Method of construction (a relatively new process for vertical positioning of massive objects) has been assembled in an Engineering Manual. The detailed manual is available only to architects and structural engineers, who must address their requests to the United States Lift Slab Corp., Perry Brooks Bldg., Austin, Tex. The cost is $5.00.

Traffic studies . . . The impact of arterial traffic on surrounding residential areas is the subject of a recent study announced by the Westchester County Department of Planning. Entitled "Traffic Impact," the study tells how to lay out and construct new roads with a minimum of disruptive effect and should be directly applicable in planning future arterial routes. Inquiries should be sent to the Westchester County Department of Planning, 910 County Office Bldg., White Plains, N.Y.

Atomic energy . . . The "Atomic Energy Guidebook" is the title of a comprehensive sourcebook covering every phase of the atomic energy field of interest to civilians. In addition to a six-part directory, the publication has sections entitled "How to Enter the Atomic Energy Business' and "Basic Information on Status and Future of Atomic Energy." It is edited by Walter A. Shead, and published by Callahan and Hallowell, to whom orders should be addressed at 1420 New York Ave., N.W., Washington 5, D.C. The selling price is $7.50 a copy.

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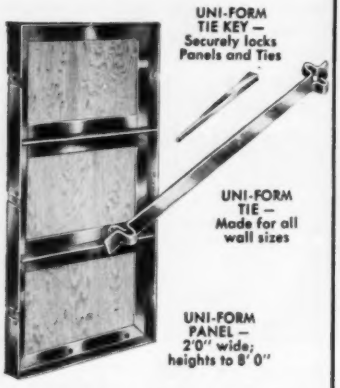

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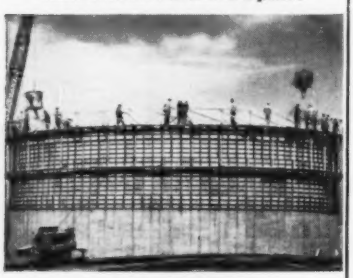

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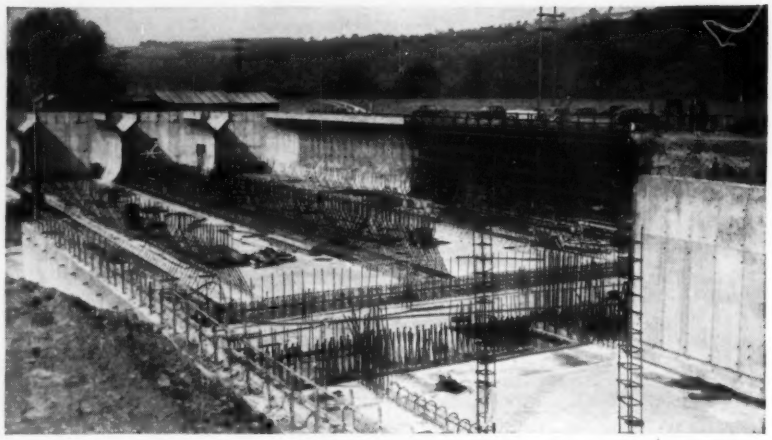
Unique Prefab Form System Speeds Sewage Plant "Y" Wall Construction



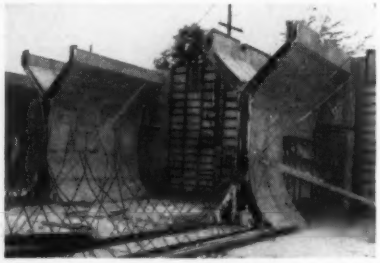
MECHANIZED FORMING with new "Y" wall trusses and UNI-FORM Panels speeds construction, saves labor and material

Field reports on a new system for forming "Y" walls in aeration tanks and settling basins indicate very satisfactory operation and important labor and material saving advantages for the system.

Developed by the Universal Form Clamp Co., Chicago, the new system is said to completely eliminate the many problems and difficulties encountered by contractors in forming this special type of wall in sewage disposal plant construction.

Specially designed trusses, which can be made to handle any type, height, shape or wall thickness, are used in conjunction with standard UNI-FORM Concrete Forms to form the "Y" wall. Assembly of the truss and UNI-FORM Panels into a complete form, ready to receive concrete is a fast, mechanical operation. Positive internal spreading and accurate wall thicknesses are assured by the use of Universal Spiroloc Cone Nut Assemblies.

Features incorporated in the design and operation of the Universal "Y" wall forming system eliminate the necessity of additional lumber or tying devices for the alignment and bracing of the unit.

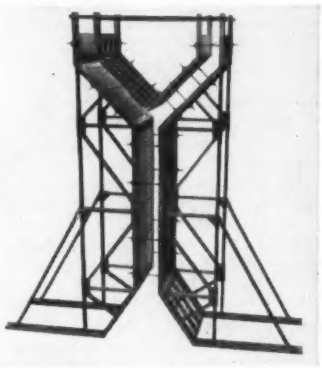


STRIPPED WALLS are clean and accurate

Erection, stripping and movement of the form can be handled either as individual pieces or as a large unit. Both methods have been very successfully used on recent projects.

Because standard UNI-FORM panels are used to form a large percentage of the "Y" wall contact area, it is possible to strip all UNI-FORM panels within a very short time after the actual pouring of concrete, leaving the trusses in place to provide the necessary support for the required period of time.

In this way, faster forming cycles, using minimum UNI-FORM equipment are possible, resulting in lower labor and material costs. UNI-FORM Panels are rented or sold, or rented with an option to purchase.



ASSEMBLED SECTION of "Y" wall truss with UNI-FORM Panels

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Construction continues its upward spiral? It's now official that 1955 broke all records for construction expenditures and volume (even after making due allowance for price changes). The grand total of $\$42^1/_4$ billion, which represented a new high for the ninth successive year, was 12 percent above the 1954 figure. Department of Commerce estimates lead off the "News Briefs" section.

1956 promises to be a great year, too? This is the inevitable impression gained from expansion plans of two major industries. Steel magnate Benjamin Fairless, M. ASCE, has announced that the steel industry has a $3 billion expansion program for the next three years ($1 billion a year), and General Motors president Harlow Curtice has revealed plans of his company for a billion-dollar program next year. The steel program will step up the annual rate of expansion from 3,500,000 to 5,000,000 tons.

Experts recommend revision of the ACI Building Code? Recent rigid-frame failures in a concrete warehouse designed for the Army according to the code have led to a searching examination of the behavior of the structure. The design questions raised and broad conclusions are reported in an article by Edward Cohen, J.M. ASCE (page 45).

The President has proposed a new water program? Adequate supply and flood protection are stressed in a long-range resources program just submitted to Congress by President Eisenhower. The program, which was prepared by three Cabinet members, calls for a bigger role for state, local, and private interests in developing water resources projects in cooperation with the government. It also urges creation of a coordinator of water resources in the executive office of the President.

The Passamaquoddy power plan is in the news again? The House of Representatives has approved a $30,000,000 survey of cost and economic feasibility of the Passamaquoddy tidal power project. A wholly American project, involving only Cobscook Bay in Maine and requiring an expensive pump-storage feature to assure power during slack tides, was begun and abandoned in the thirties. The present proposal is for an international undertaking involving both Cobscook and Passamaquoddy bays. It would be a two-pool system and would not require pumping.

An electronic brain is being tested by the Corps of Engineers? An electronic computer that breezes through simultaneous equations and least squares has been developed by the Army's Research and Development Laboratories at Fort Belvoir, Va., and the Monrobot Laboratory at Morris Plains, N.J. Called Monrobot V, it will speed up triangulation calculations for military maps by making figuring "faster, easier, cheaper, and more accurate than ever before."

The cost of converting sea water has been reduced? Use of the sea as a potential source of water supply moves a step nearer reality with an announcement from Secretary of the Interior McKay that sea water can now be converted to drinking water at about the highest present cost of purifying ordinary municipal water. Congress has authorized $10,000,000 for a fourteen-year research program.

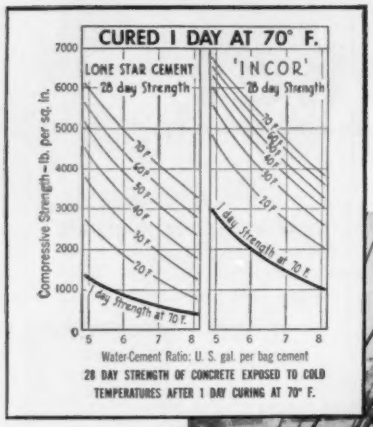
Information for the 1956 Membership Directory is needed? In case you missed the notices last month, March 15 is the deadline for receiving information for the new Membership Directory. If you want the Directory to carry up-to-date information about yourself, please use the coupon in the advertising section.

Atomic radiation is being studied experimentally for sterilizing the sewage of the City of Los Angeles? Hyperion Engineers, who have completed final drawings for a $40,000,000 modification and improvement of the city's treatment and disposal works at Hyperion, are undertaking an investigation to obtain comparative costs for the radiation method and traditional methods of treatment and disposal by a seven-mile sewer outfall. Cooperating in the investigation is the Nuclear Science and Engineering Corporation, of Pittsburgh.

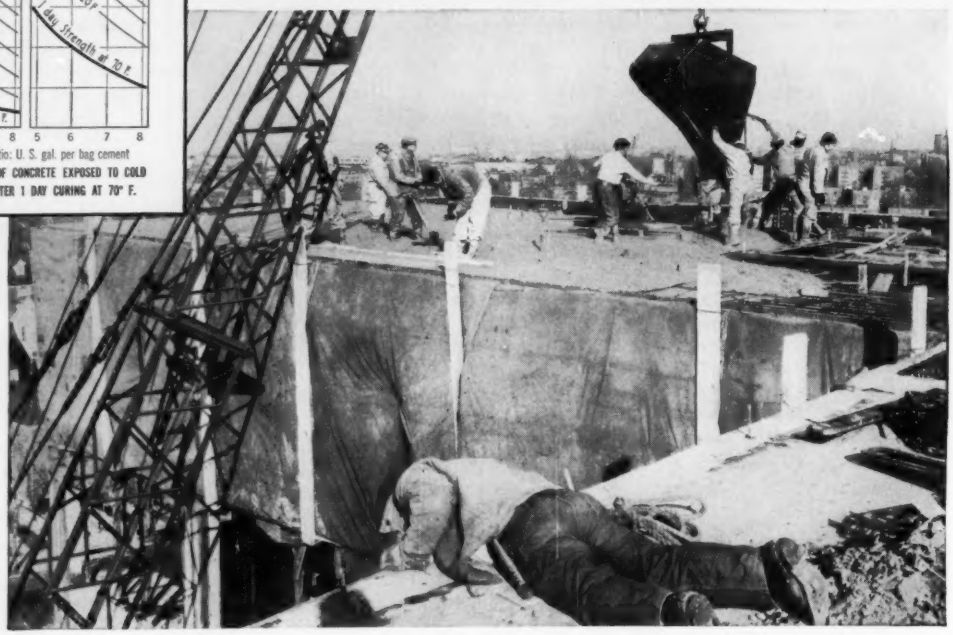
There is a coal-stripping shovel with a 90-ton bite? In operation on properties of the Hanna Coal Company's Georgetown No. 12 mine near Cadiz, Ohio, is the world's largest power shovel, unveiled on January 19. The $2,600,000 colossus, with its 60-cu yd shovel, can pick up 90 tons of overburden in one scoop, swing it the length of a football field, discharge it at the height of a ten-story building, and return for a second bite in 45 seconds. Fabricated by the Marion Power Shove Co. and General Electric, the unit is being used to uncover coal seams lying as deep as 90 ft below the surface.

A $51,500,000,000 highway bill is now before Congress? Introduced on January 26 by Representative George H. Fallon, Maryland, the bill calls for the expenditure of state and highway funds over the next thirteen years, with financing of the federal share to come from higher taxes, principally on motor fuels. The pay-as-you-go feature of the bill is reported to have the approval of leaders in both Houses. Congressman Fallon's speech before the ARBA earlier in January is reported on page 75.

'INCOR' Changes Winter into Summer



Strength-test results in Lone Star Cement Research Laboratories, confirmed by nearly thirty years' field experience, show why 'Incor' makes year-around concreting economically practicable.



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With 'Incor' and only one-day heat protection, forms were stripped in 24-48 hours, even at lowest outside temperatures. Each pour was protected by canvas, and heaters using propane gas provided steady, clean, uniform heat, with minimum labor costs. The Contractor says—Closing out the job with 'Incor' saved 4 weeks' time (with correspondingly reduced job overhead), and cut heating costs by two-thirds, saving $1.05 per cu. yd. of concrete.

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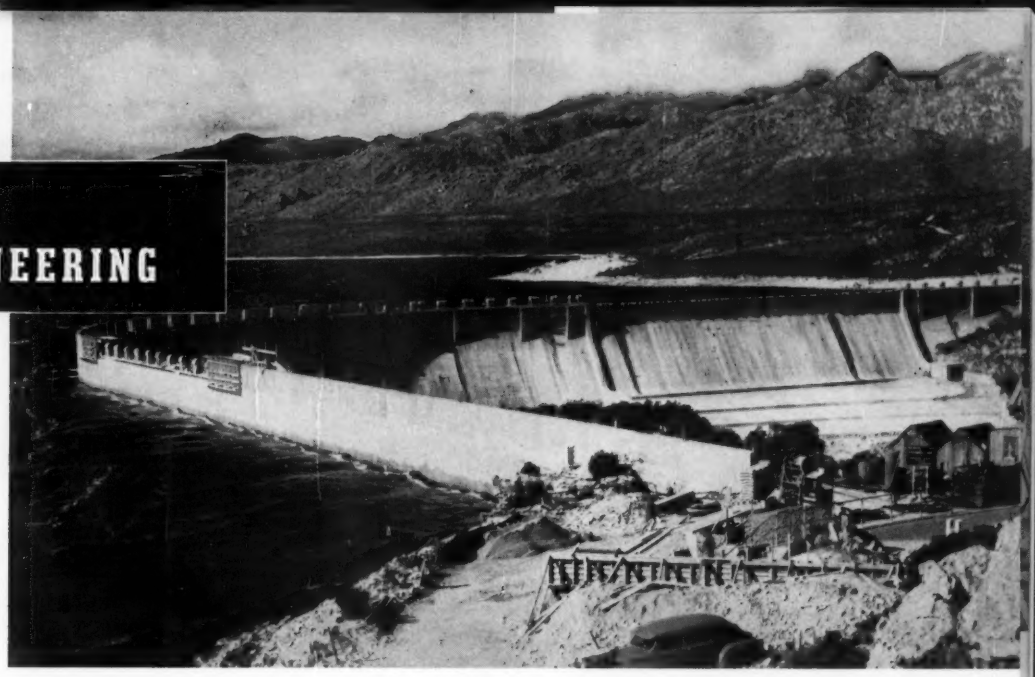
CIVIL ENGINEERING



Cantilever wall constructed on, and anchored to, top of dam provided freeboard for addition which raises storage level 6 ft 6 in. In foreground raising has been completed.

Steenbras Dam strengthened by post-tensioning cables

S. S. MORRIS, M. ASCE

City Engineer, Capetown, Union of South Africa

Author Morris (left) talks with Enoch R. Needles, President of ASCE, at Society's 1955 Annual Convention in New York, where Mr. Morris presented paper on which this article is based.

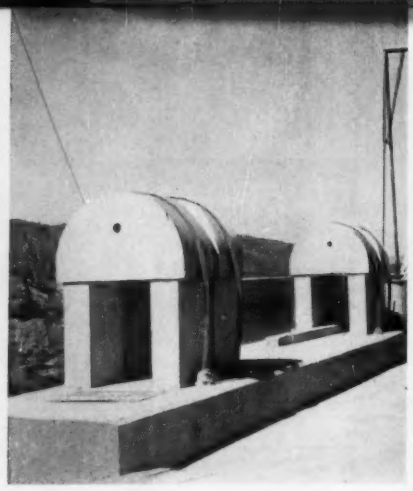
Steenbras Dam, the main source of the water supply of Capetown, Union of South Africa, had been raised to a height of about 80 ft in 1927, as shown in Fig. 1. The serious water shortage which developed in the postwar period led to the decision to again raise the dam. This time the spillway crest was raised 6 ft 6 in.

The current water shortage reflects the unprecedented expansion in trade and industry which has characterized the postwar decade in South Africa. Capetown, at the southernmost tip of the African continent, and legislative capital and mother city of the Union, has felt to the full the nationwide trend. Its growth has been so rapid that the provision of services to its 600,000 inhabitants has tended to fall in arrears. Nowhere is this better illustrated than in water supply, where the current consumption is about 31 mgd, or just double the prewar figure.

In 1951 Parliament empowered the city to develop a new water source. In the same year a special Board of Engineers was appointed, with the writer as chairman, to supervise this plan. Since the project would require a considerable period to complete, it was evident to the Board that stop-gap measures

Diamond drills were used to drill holes for post-tensioning cables. Holes extend through concrete of dam and about 33 ft through foundation rock. Into these holes cables were threaded and lower 8-ft length grouted in before tensioning.

Vibrator is attached to a cable while it is being grouted into foundation rock. Anchorage covers approximately lower 8 ft of cable length. Foundation rock was generally of excellent quality.



In foreground cables have been draped over cable heads and anchored in, ready for post-tensioning. In background, one of the precast, reinforced-concrete cable heads is being slung into place.

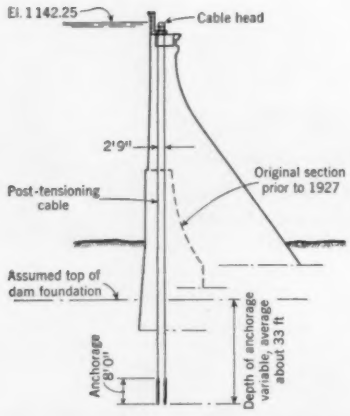


FIG. 1. In typical section of Steenbras Dam, original section before 1927 raising is indicated by dashed line and 1953 raise by gray portion at top. This section is taken through one of post-tensioning cables, which runs over precast cable head at top and has each end grouted into foundation rock. Tension was introduced into cable by raising cable head with hydraulic jack, and holding head in raised position by inserting precast packing blocks.

would be necessary. The unusually dry summer of 1953–1954 [winter, of course, in the northern hemisphere], when Capetown experienced its first water restrictions in many years, justified the Board's fears in this prespect.

One of the most promising stop-gap measures considered by the Board to provide more water for the city was the raising of Steenbras Dam, with an assured yield of 20 mgd. A further reason for the work on this dam was that an earlier investigation had indicated the spillway capacity to be inadequate. The spillway had been designed for a discharge of about 2,800 cfs, equivalent to a flow of only 107 cfs per sq mile (the catchment area being 26.2 sq miles). A flood of 7,300 cfs, giving a discharge of 3,800 cfs, had already been registered and, on the basis of hydrological evidence elsewhere in the country, it was considered desirable to design for a flood peak of 17,000 cfs.

The stability of this mass concrete gravity structure (Fig. 1) under conditions arising from a 17,000-cfs flood were analyzed on the basis of design criteria adopted by the U.S. Bureau of Reclamation. The analysis showed that the structure might well fail under a flood of this magnitude since the resultant force, using the Bureau of Reclamation's extreme load criterion, fell altogether outside the section.

Remedial measures could not be neglected. The following alternative plans were studied, some for strengthening only, and others for raising also: (1) Cutting down the existing spillway; (2) gravity strengthening, (3) constructing an additional gate-controlled spillway; (4) constructing a syphon spillway; (5) strengthening the existing dam by prestressing with post-tensioning cables.

Advantages of post-tensioning

The advantages offered by post-tensioning were evident at an early stage of the investigations. Construction would be rapid—a most important factor in view of the urgent need for additional water. Substantial financial savings appeared possible over other more orthodox methods. It would not be necessary to disturb the rock gardens immediately below the dam, which have become an outstanding attraction and have proved a constant source of pleasure both to the citizens of Capetown and to visitors. Also, the post-tensioning would be a permanent asset in the event of a further major raising (which may well soon be necessary) since the prestressing force can be taken into account for stability calculations no matter what method is adopted for further raising.

The Board of Engineers, after inspecting the site, concluded that the foundations had sufficient strength to provide the necessary anchorage for the cables. The Board was particularly fortunate in having as one of its members an engineer who had been associated with the construction work in a previous raising of the dam. This Board member was able to give positive assurance of the quality of the foundation rock.

There was doubt on only one point—the possibility of corrosion of the prestressing cables by the soft, acid, brown water of the Steenbras catchment.

Stretch of a test cable and load on it are about to be checked with 300-ton hydraulic jack (above center). Design tension on each cable is no less than 70 tons, with 10 percent added for creep and relaxation.

After cable has been post-tensioned, pipe of small diameter is inserted to bottom of hole for final grouting (photo at right). Note packing blocks placed under cable head to retain tension in cable.

However, after an inspection of conditions, proposals were put forward which gave assurance that this danger could be avoided.

A cost-benefit analysis indicated that a 6-ft 6-in. raise in spillway level by the post-tensioning method would offer the greatest advantages. The plan adopted envisaged a free spillway of the existing length, with the water level rising 5 ft 6 in. above the crest during peak flood conditions, thus requiring strengthening of the structure for a total additional head of 12 ft.

In January 1953 a contract was negotiated with a contractor skilled in the highly specialized operations involved. For the design of the main works the contractor engaged the services of André Coyne, Hon. M. ASCE, and no time was lost in submitting a detailed design, together with a draft specification and schedule of quantities. Before the end of February 1953, the contractor was moving equipment to the site, and on March 1, 1953, the work was formally commenced.

The effect of embodying post-tensioned cables in a gravity dam near its water face is to add at any section a vertical force which, by reducing the overturning moment and by developing greater friction forces to resist sliding, provides additional resistance against the two principal causes of failure. Prestressing therefore makes it possible to strengthen a dam that requires raising or one that has been underdesigned, assuming of course, that the foundation is capable of resisting the additional loads.

In the design for the raising of the Steenbras Dam, no tension was allowed at the upstream face at any section, and the maximum permissible value of the coefficient of friction required for the balancing of the horizontal forces (shear in the concrete being neglected) was taken to be 0.75. Uplift pressure was taken as 0.6 of the full static head at the upstream face, diminishing to zero at the downstream toe. Uplift was assumed to act over the whole area of the section.

Calculation of cable stress

The first step in designing the prestressed cables for raising the dam was to calculate the total vertical force required for stability at any section. Since the cables run from top to bottom and are designed for the critical section, there is an additional factor of safety at other sections.

As is the case with all prestressed concrete structures, allowance must be made for the effects of creep in the concrete and relaxation in the cables. The applied prestress must be made significantly higher than the ultimate tension required. As a result, the cable is more heavily stressed during initial tensioning than subsequently. Thus the operation of prestressing provides a valuable test of the strength of the cable and of its anchorage in the foundation rock.

The original Steenbras Dam was a gravity concrete structure. See Fig. 1. It consisted of a curved portion and two straight flanks, in which precast concrete blocks were used as forms. It was raised in concrete to its present height in 1927.

Expansion joints were provided on the raised structure at 40-ft intervals. The water seal was effected by copper strips, but no interlocking concrete keys were used. In calculating the prestress required, therefore, each block between expansion joints on the flanks was considered separately, a sufficient number of cables being provided in each to ensure stability.

It was assumed that the curved central part of the dam would function as an arch. This assumption was supported by observations in the inspection gallery, since the construction joints which intersect the gallery were completely closed and watertight in the central part of the dam, whereas those on each flank showed appreciable opening and in some cases slight leakage. The curved part of the dam, acting as an arch, was found to be more than adequately stable, even under the loading developed with a considerable degree of raising, and it was therefore unnecessary to strengthen it.

The prestressing cables must be anchored at a depth sufficient to ensure adequate resistance against pulling out of the rock. On a semi-empirical basis, it was assumed that the tension in a cable is resisted by the weight of the overlying rock contained in an inverted cone with its apex at the mid-point of the cable anchorage. Where the cables are close together, the cones overlap, and this must be taken into account in assessing the weight of rock available. On the basis of observations made during a personal visit of inspection to the Steenbras Dam, Mr. Coyne decided on a value of 45 deg for the cone half-angle at this site.

To give complete assurance of safety, an 8-ft length of cable anchorage was adopted, and wherever foundation rock

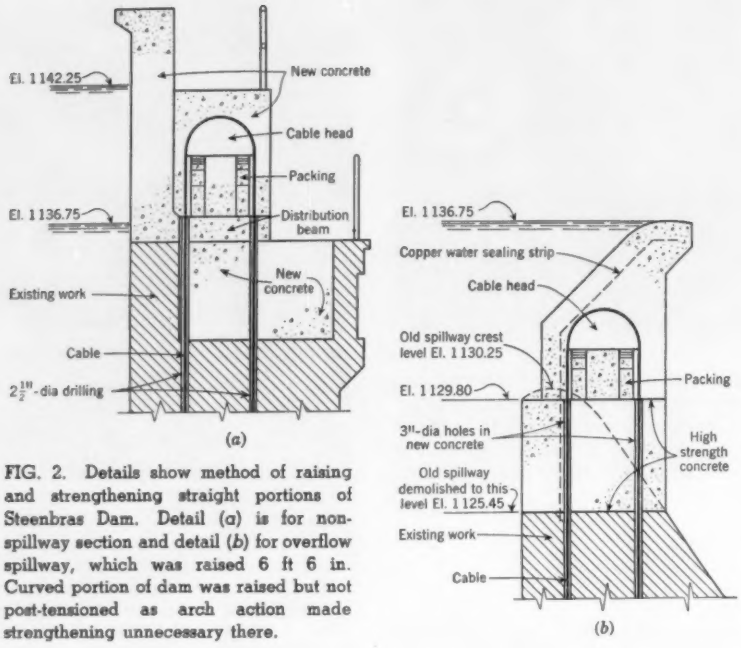


FIG. 2. Details show method of raising and strengthening straight portions of Steenbras Dam. Detail (*a*) is for non-spillway section and detail (*b*) for overflow spillway, which was raised 6 ft 6 in. Curved portion of dam was raised but not post-tensioned as arch action made strengthening unnecessary there.

of subnormal quality rendered it necessary, the specifications required that the anchor holes be under-reamed.

The cables are made up of steel wires of 0.20 in. diameter and 213,000-psi ultimate strength, with the 0.15-percent proof stress (as defined in British Standard No. 18 of 1950) to be not less than 157,000 psi. Each cable is 1.4 in. in diameter and made up of 37 wires. The minimum diameter of hole to be drilled through the concrete to accommodate the cables was fixed at $2^1/_2$ in. The calculated stress required on each cable was 70 tons. To allow for creep this brought the initial tension required to 77 tons.

In the event that the dam is again raised, the cables now installed will still retain their full value in applying a stress to the lower sections, but it will be necessary to install a certain number of additional cables to provide additional resistance against the further increase of the forces acting on the dam. Spacing of the post-tensioning cables was designed to allow room for later installation of additional cables.

Cables were designed on a semi-endless system, whereby each would run from anchorage to anchorage over a semicircular precast concrete head, as shown in Fig. 2. This rendered tensioning of a cable a simple process. To apply the tension, a hydraulic jack was placed under the cable head which, after the load had been applied, was kept in its raised position by precast concrete packing blocks.

Computed stresses in the cable heads were found to be high. Since the strength of these heads is important, their design was checked by full-scale testing to destruction, undertaken in Paris under the personal supervision of Mr. Coyne. The precast concrete packing blocks, also highly stressed, were heavily reinforced.

Compression stresses on the dam, immediately below the packing of the cable head, were of course also high. To spread this stress at a low intensity to the concrete of the existing structure, a distribution beam was provided. This consists of a layer of high-strength reinforced concrete of 12-in. minimum thickness, except on the spillway, where the whole first lift of concrete up to the stressing level is of high-strength concrete, with reinforcement placed just below the stressing level.

The raised part of the dam was designed over its whole length as a cantilevered retaining wall anchored by reinforcing bars grouted into drill holes in the existing concrete. On the non-spillway section, the cable heads are behind the retaining wall and the cables are completely encased in concrete to obtain protection against weathering as well as for esthetic purposes. On the spillway, the heads are embodied in the uppermost lift of concrete which forms the crest.

Provision of a spillway of the conventional type, in which the profile follows the nappe, would have been difficult. It was therefore decided to adopt a profile which permits the nappe to spring clear, as shown in Fig. 2 (*b*).

The water of the Steenbras Reservoir is typical of a moorland catchment, and since its pH is as low as 5.05, every precaution was taken against possible corrosion of the cables. To reduce the possibility of the acidic water reaching the cables, the cable holes were kept as far back as practicable from the water face of the dam and were pressure-grouted before the cables were inserted as well as after tensioning and testing had been completed. The cables were thus entirely sealed within a waterproof cement medium. As an additional precaution, all water in the cable holes was kept alkaline during the period between anchoring of the cables and their final grouting.

The allowable drift from the vertical of not more than 1 in. in 10 ft ensured that holes did not cross or run into each other, and the straightness restriction of not more than $^1/_2$ in. in any 10-ft section ensured against undue friction on a cable during the application of prestress. Specifications required that 21 days should elapse between grouting in the bottom of the cables and tensioning them.

The total pull required on a pair of cables was $2 \times 77 = 154$ tons, and the specification called for the use of 200-ton jacks with safety nuts on their heads which could be kept up with the raises as jacking proceeded.

After a period of 28 days from the time of tensioning, each head was jacked up just clear of the packing and the load ascertained. If it exceeded 70 long tons per cable, the cable was deemed satisfactory. If it was less than 70 long tons, the head was again jacked up to 77 tons per cable. Then after 14 days it was again tested.

For all practical purposes the contract was completed within 18 months after the commencement of work. By mid-August 1954, the reservoir was overflowing at the new design crest level. The water thus made available proved of inestimable value during the ensuing summer.

In the Steenbras area, the Table Mountain sandstone on which the dam is built, dips steeply and consists of extremely hard layers interbedded with softer material. This characteristic rendered percussion drills useless since they tended to follow the dip down the hard layers, and diamond drills had to be used to keep the holes within the specified tolerances. Another difficulty arose from the fact that the original concrete structure contained pieces

of wood, bits of reinforcement, wire form ties, and other obstacles that seriously interfered with drilling to tolerance. In many cases holes had to be drilled a number of times before they would pass through an obstruction without a kink; and in a few cases holes had to be relocated.

With a few exceptions holes were watertight in the concrete and at the rock contact, but showed heavy leakages at 10 to 30 ft into the rock. Some of the leaks exceeded the pumping capacity of 1,500 gal per hour, and to meet this difficulty the amount of grouting was increased. Pressure was applied up to a maximum of 200 psi, and to avoid dangerous uplift on the wall, relief points were arranged at groups of holes adjacent to those being grouted. Grouting was continued until leakage was reduced to less than $1^1/_2$ gal per hour.

Raising has been completed in this view of dam. Curved section was raised but not post-tensioned, as arch action provided sufficient strength.

Grouting of anchorages

The method adopted for grouting the cable anchorages was as follows. To avoid airlocks, the grout was put into a 6-in. cylinder from which it was discharged by piston into a placer of 2-in. inside diameter and 13 ft long. It thus became possible to use a much thicker grout, with a water-cement ratio of 0.25. The placer tube was fitted with a piston which could be driven down by air pressure to extrude the grout at the bottom. To eliminate turbulence, the placer tube was fitted at its lower end with a nozzle 9 ft 0 in. long, of 1-in. outside diameter, and a foot valve which opened only on contact with the bottom of a hole. The cables were inserted into the grout slowly and under control.

Each cable length was made up complete in the manufacturer's works, with brushes, bindings and shoes, and marked with a metal tag giving its number on the wall and exact length. Delivery was arranged to suit the construction program, and cables were anchored as soon as possible after arrival. They were fed into the holes by hand, one end at a time, without any notable difficulties. All 28-day tests showed residual tensions above the design figure of 70 tons.

Out of a total of 326 individual cable legs placed, only six failed. Careful investigation revealed the causes of failures to be grout dilution, excessive enlargement of holes in the drilling, and deviation of holes from the vertical. All failures occurred on long cables which had been allowed to run into the grout too rapidly. Immediate steps were taken to eliminate such weaknesses in placing, and no further failures occurred.

Experiments during construction showed that once a hole had been pressure grouted, there was sufficient residual alkalinity to neutralize the acid water in the hole, and no protection of cables was therefore necessary once they had been anchored. For the final grouting, $^1/_4$-in. steel tubing, flush-joined in 10-ft lengths, could be worked down to the top of the anchorage grout with ease. It was thus possible to flush holes out thoroughly before finally grouting up, and then to fill them up from the bottom, displacing the water. The grout thus used for filling was of a water-cement ratio of 0.65.

Before the final grouting was started, holes were blocked with a neat cement plug through which a $^3/_4$-in. tube was inserted. The $^1/_4$-in. tubing referred to above was passed through the $^3/_4$-in. tube, and grout was pumped down till all water had been displaced. The final seal was made by injecting cement at 200 psi through the plug after withdrawal of the $^1/_4$-in. tube. During this process considerable leakage of grout occurred through the strands of the cable, giving positive assurance that the final seal was completely watertight.

The processes utilized in strengthening and raising the Steenbras Dam were, so far as dam construction is concerned, entirely new to South Africa. Indeed, apart from certain dams post-tensioned in France and French North Africa, where the process was pioneered by Mr. Coyne, the method had not been exploited anywhere else in the world.

From a purely financial point of view, the project can be considered eminently successful. The total cost to the City Council of all the work described was £110,000. By raising the height of the dam, an additional 1,552 million gal of water were stored during the first winter rains (which here come in August). The value of this additional water at the statutory charge of 2s. 3d. per 1,000 gal was £174,600 so that the sale of this water during the summer of 1954–1955 [winter of course in the northern hemisphere] more than covered the cost of the project.

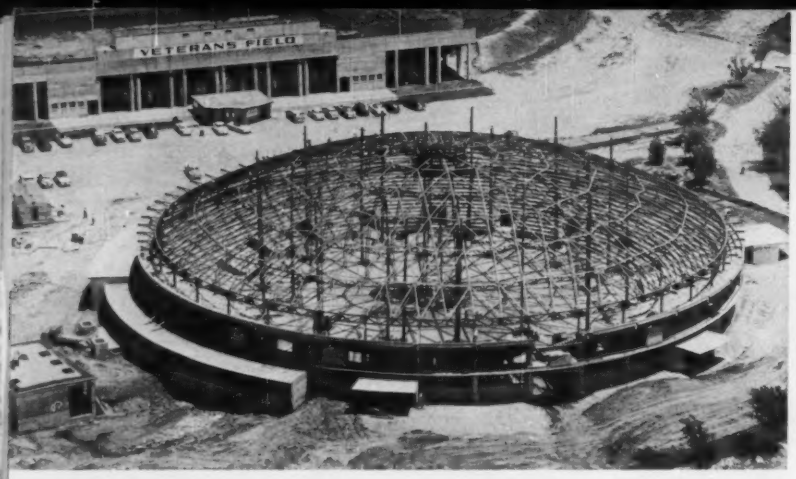
The author is happy to record his thanks to W. S. Garrett, Manager, the Cementation Company (Africa) (Pty.) Ltd., for his valuable collaboration in preparing this article.

The Board of Engineers, Augmentation of Water Supplies, Capetown, comprises S. S. Morris, M. ASCE, City Engineer, Capetown, Chairman; N. Shand, M. ASCE; and J. L. Savage, Hon. M. ASCE.

Members of the City Engineer's Department, Capetown, associated with the work were: D. C. MacKellar, A.M. ASCE; J. G. Welsh, M. ASCE; B. D. Kark, A. M. ASCE; and D. Lipsett.

The contractors were the Cementation Company (Africa) (Pty.) Ltd. Their engineers prominently associated with the project were Messrs. C. Grundy, P. I. Parker, A. M. ASCE, W. S. Garrett, D. A. North, J. G. Gräbe and R. T. Shaw. The contractors' consultant for the project was André Coyne, Hon. M. ASCE.

(This article was prepared from a paper presented by Mr. Morris at the ASCE Annual Convention, before a Power Division session presided over by R. A. Sutherland, Vice Chairman of the Division's Executive Committee.)



Spherical lamella dome built in Wichita

University fieldhouse will seat 10,235

DAVID E. STEVENS

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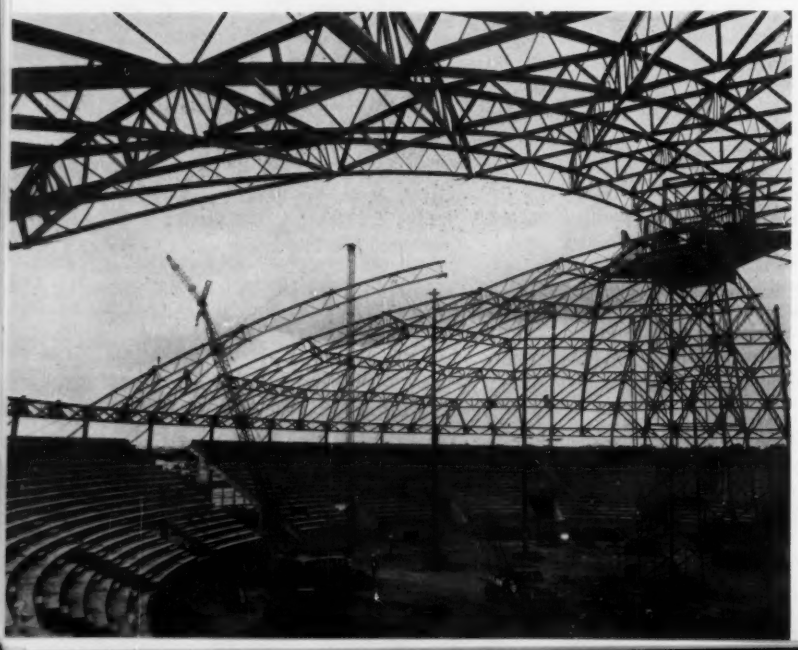
A unique application of the lamella type of roof has now been completed at Wichita, Kans. The new fieldhouse of the University of Wichita, with a permanent seating capacity of 10,235 persons, will take its place among the larger enclosed places of public assembly in the nation. Although this building, which is being constructed at a total cost of $1,405,700 ($11.05 per sq ft), has many outstanding features, one of the most interesting is the lamella dome roof of 267-ft diameter, framed of structural steel.

The primary purpose of the fieldhouse is to provide an arena for varsity college basketball and facilities for the university's physical education program. Because of its proximity to downtown Wichita, however, it is expected that the building will be frequently used for community functions, ice shows, and theatrical productions not requiring stage facilities. A modern heating and ventilating system (including radiant floor-panel heating in the locker-room area) and color-corrected mercury-vapor lighting for the arena, will insure maximum comfort to patrons and participants alike. An extensive parking area will provide parking space for 2,000 cars. Parking lot paving of crushed stone is being laid under a separate contract.

The fact that there is less unused space in a circular building, and that radial aisles provide maximum efficiency of access and egress, dictated the architectural form of this building. The architects were also aware that through the use of peripheral seating, none of the 10,000 seats would be farther than 86 ft from the stage area.

Economy and speed of erection were two of the primary factors leading to the decision to use a structural steel roof. Foundation conditions made the use of a tension ring to take the arch thrust imperative. The soil at the site is a clay subject to movement with varying moisture conditions, and the



First steel lamella dome in United States covers University of Wichita fieldhouse. Spanning 267 ft, dome was designed as analogous to a thin-walled shell. Rib trusses and ring girders are 39 in. deep. Erection of outside ring girder was completed around entire periphery before start of roof erection proper. One main radial rib truss was erected first, and then diagonal rib trusses were placed from outside toward center, as shown in construction view at left.

structural engineer felt that buttresses or a similar arrangement to take the thrust would not prove dependable. The fact that the lamella roof could be fabricated in much smaller sections helped influence the architects to adopt this system. It was their thought that this would encourage more competitive bidding for the steel contract, since it would be within the scope of small as well as large fabricators.

Although many steel-framed domes have been constructed in this country (notably the Charlotte, N.C., Coliseum, the world's largest, with its 332-ft clear span), and also several steel lamella broached-arch or "barrel-type" roofs, the Wichita University fieldhouse is unique in that it is the first steel dome to be constructed using the lamella system. The development of this system is very interesting. It was engineered, detailed, supervised, and is now being tested by Roof Structures, Inc., of Webster Groves, Mo. The finished structural design was made by Louis Bass of that organization, but prior to that, much consultation went on with national experts in the structural field. During the course of these consultations, many design theories were examined and discarded. Approximately three months of time and over $5,000 were expended in research on the problem before it reached the contract stage.

At first the simplest solution seemed to be to consider the dome structure as made up of a number of three-hinged arches. This approach was discarded, however, because it made no practical use of the internal circumferential forces which would permit a simple, uniform distribution of frame dead loads. An exact space frame analysis was then considered, but also discarded when it proved very involved and cumbersome. The solution finally adopted considers the frame analogous to a thin-walled shell, and engineers of Roof Structures, Inc., are now engaged in tests on the completed structure to verify the accuracy of the design assumptions. During the analysis, a model was constructed to a scale of $1/8$ in. = 1 ft, which proved very helpful in the design work and in preparation of shop drawings.

In addition to the structural design proper, the actual geometry of triangulating the spheroid posed quite a problem. The physical geometric solution was devised by E. A. Lampitt and Associates, consulting engineers of Pekin, Ill., who also checked the final drawings and stress calculations. Dr. Gustav Mesmer, Professor of Applied Mechanics of Washington University, was a consultant on the geometrics.

In addition to the above, credit should also be given to Prof. Jan J. Tuma of Oklahoma Agricultural and Mechanical College, who devised the final approach to the structural analysis; and to Louis Bass, who not only made the structural design and analysis, but also supervised the shop drawings, checked the geometrics, and supervised the construction. Dr. G. R. Kiewitt, Vice President of Roof Structures, Inc., coordinated and supervised the entire job.

The roof structure is supported on thirty-six 10 WF 39 columns, each having a 3-in.-diameter pin connection at the base to permit a hinged movement as the roof expands or contracts. A trussed ring-girder 39 in. deep rests on top of the columns and runs the entire perimeter of the building. The total weight of this ring girder is 65 tons. Into this ring girder, twelve radial trusses are framed. These span the entire distance to the center compression ring or "lantern." Also framing into this ring girder at intermediate points are curved roof trusses which parallel the radial trusses. These intermediate trusses intersect each other, resulting in the characteristic diamond-shaped pattern of the lamella system. The outward thrust of the dome is carried by four tension rings which are welded on or near the ring truss. The largest of these tension rings is a flat plate 10 in. wide and $1\frac{1}{2}$ in. thick. In the tension rings alone there are 65 tons of steel. The depth of the roof trusses is 39 in. All trusses (including the ring girder) are of Warren type, fabricated of split beam T-sections for chords, and angles for web members, with shop-welded connections.

The "lantern" or center compression ring is a polygon with twelve sides, the long diameter being 24 ft 0 in. It consists of two continuous 10-in. 25-lb channels, one each in the plane of the roof-truss top and bottom chords. These channels are horizontal and are laced to act as a single compression member. Stub columns on top of this compression ring create a small clerestory 6 ft 6 in. in height. This is the only point where the roof deviates from a perfect spherical form.

The diameter of the roof, center to center of supporting columns, is 267 ft 0 in. Cantilevered beams framing into the outside of the ring girders, however, increase the total diameter of the steel roof framing to 284 ft 5 in. The rise of the dome is 37 ft 6 in., and the spherical radius is 277 ft 6 in. There are a total of 432 tons of structural steel in the roof structure, or approximately $13\frac{1}{2}$ lb per sq ft of projected area.

The actual erection of the roof required only 14 days. In that period two crews erected 432 tons of steel over an area of 65,000 sq ft. Comparatively little falsework was required. It was at first contemplated that the only falsework to be used in erection would be the central tower supporting the compression ring shown in the photographs. Poles were added when the roof deflection caused difficulty in making connections. It is interesting to note, however, that after all welding was completed and the shores were removed, the deflection was less than one inch.

The roof is made up of twelve identical pie-shaped sections, connecting to the trussed girder ring on the outside, and to the compression ring at the center. The trussed girder ring was first erected on the pin-connected columns around the entire periphery. One of the main radial roof trusses (each shipped in three sections) which divide the twelve sections was then erected. Next the diagonal trusses were tied in, working from the lower outside ring girder up to the compression ring. The two crews worked on opposite sides of the building and each worked around the building in one direction until closure was effected. All connections were then field welded, and temporary shoring was removed. Field welding on this job required four weeks for nine welding operators. According to the erection foreman, the job went up with unusual ease.

The all-welded, exposed structural steel frame actually enhances the attractive interior of the building. The soffits of all trusses have been painted a brilliant red, which contrasts with the grey lead paint used on the rest of the steel and emphasizes the diamond pattern of this unusual system.

The $1,405,700 total cost of the fieldhouse comes to $11.05 per sq ft of floor area. The structural frame, from column bases up, cost $2.9575 per sq ft, including the fee of Roof Structures, Inc.

Architects on the fieldhouse are Schmidt, McVay, and Peddie of Wichita. Engineer on the structure, exclusive of the roof, was G. Hartwell and Co., also of Wichita. The steel was fabricated by Watkins, Inc., a Wichita, Kans., member of the AISC, and was erected by the John F. Beasley Construction Co. of Chicago, Dallas, and Muskogee, Okla. The general contractor was Dondlinger & Sons Construction Co. of Wichita.

The toughest part is under the

Substructure for New Orleans' record cantilever

CARL B. JANSEN, M. ASCE, President, Dravo Corporation, Pittsburgh, Pa.

As in every industry worth its salt, technological changes are always in progress, and these have been substantial in the construction of bridge foundations. Before 1930, most pier foundations were built by sinking reinforced concrete caissons. Usually provision was made for the use of compressed air in case unexpected water-bearing soils were encountered, even though the operation might be planned for open dredging. The caisson generally was employed for going down any appreciable distance beyond the limits of timber-sheeted cofferdams, and the then somewhat novel interlocking steel sheetpile, single-skin cofferdam. The caisson method was commonly used for piers 35 to 45 ft deep. When the pier was to be seated on rock, compressed air was often used for the final stages of sinking and for cleaning out and sealing.

In the middle 1920's, techniques were developed for using cellular steel sheetpile cofferdams which eliminated the main difficulties that had been experienced in the initial use of this method for raising the battleship *Maine* in Havana Harbor. This simple process soon came into use for unwatering large areas for lock and dam construction as well as for smaller operations, such as founding bridge piers. New procedures, using steel beams for internal bracing of single-skin cofferdams, made it possible to go to greater depths. Improved pile-driving equipment plus the use of H-beam and pipe piling, and various types of concrete piling for foundations under piers, eliminated the need for carrying masonry all the way to rock or firm foundation.

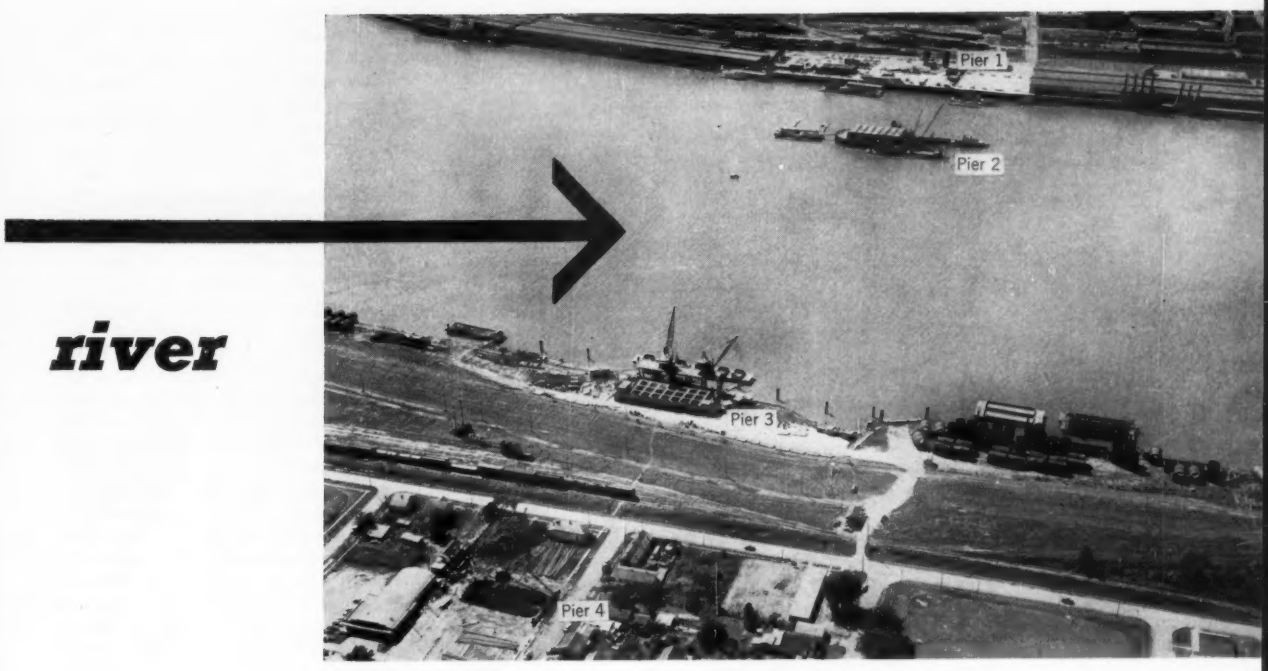
Economic factors contributed to the technological changes. Labor costs of compressed air work became almost prohibitive. A sand-hog receives 8 hours' pay for only one hour of actual work under air at depths of 99 to 110 ft below water level, and the same pay for only a half hour's work at depths of 110 to 115 ft. As construction costs increased, customers demanded the best thinking of engineers to reduce them. To get a job, the contractor had to use plenty of initiative and imagination in planning his construction method preliminary to bidding.

As the years passed, the use of reinforced concrete caissons for bridge piers came to be limited primarily to depths beyond the practical limitations of the less expensive methods. At present the open-dredged caisson is used instead of compressed air wherever possible simply because it is more economical. In any event, open-dredged caissons must be used on jobs deeper than 115 ft below water level—the legal limit for compressed-air work. Today caisson sinking is restricted primarily to major bridge foundations in this country.

There are two types of caissons for bridge pier construction—the "dry shoe" where the site is on land, and the "floater" where the site is in water. The dry shoe involves the "shoeing" of the bottom contact area or cutting edge with structural steel to protect this critical point from damage as it is sunk.

For the floating caisson, the shoe is much more elaborate, consisting of a water-tight floating cutting edge and working chamber and the bottom part of the caisson, which is anchored over the pier site. This is filled with concrete, and as it sinks exterior walls are extended upward by use of an attached cofferdam of timber and steel, while the dredging wells are carried up by attaching circular steel dredging tubes. On occasion, to permit use of the dry-shoe method for a river pier, a temporary "sand island" is built.

Every caisson is a new problem. Each has its own individual personality—sometimes quiet and well mannered and at other times perverse and ill-tempered. The matter of location control in itself involves many peculiarities. Ordinarily the caisson becomes the base of the bridge pier and must end up where the pier is supposed to be, usually within a tolerance of a few inches. On its way down, the "box" is likely to encounter almost anything from sunken barges to skeletons of prehistoric mammoths. Hardness of the bottom may differ greatly from one end of the site to the other, causing tilting. Ordinarily the only cure is to lower the high side by excavating in the working chamber



close to the cutting edge. If the caisson does not move readily, excessive digging may result, and when she cuts loose, she will probably go just as far in the opposite direction. Every time she tips, she goes off line one way or the other, and that means corrective measures, usually by tipping in the opposite direction and "walking" her back to where she belongs.

This method works fine in certain types of soil, but in other types, as for instance in running sand, the cutting edge may travel in a direction opposite to that intended. Then the distraught sinking foreman must completely reverse his strategy and take the opposite tack, only to discover when another stratum is entered that his method must again be reversed.

Skin friction on the caisson is of great importance. It is of course essential to have a sufficient weight of concrete to keep her moving downward as material is excavated beneath. This weight must also overcome buoyancy from water if sunk "in the wet," or the equivalent amount of air pressure if the pneumatic process is used. Obviously the volume of concrete is kept at a minimum by the owner to reduce cost and dead load on foundation material.

Extreme friction may be developed in sinking through some types of material—such as a hardpan of massed boulders, which have a tendency to "roll" against the caisson and bind. Other material may have lubricating tendencies, and certain types of river silt may provide totally inadequate support for proper control, and must be replaced by firm material before the shoe is set. Occasionally jetting with water or air may be necessary to reduce the skin friction. At New Orleans a special type of varnish is applied to the outside of the caissons to reduce friction. Unfortunately it is never possible to prove what would have happened if a given method had not been employed, but in this case the use of varnish is continued because of favorable results in laboratory tests.

It may become necessary to place additional load on a caisson to compensate for deficiencies in the weight of the concrete itself. Cases have occurred where the absolute maximum amount of load was added for which there was room on top of the caisson, with no appreciable result. When the weight was removed, and for no apparent reason, the caisson settled promptly.

These are only a few of the multitude of problems encountered in this business. There is no such thing as a normal caisson—this has been ascertained from bitter experience. The only solution is to expect the worst, and it is just possible that the worst will not happen. But at the heart of the problem is the necessity for keeping the caisson plumb and on line at all times. With proper care at the outset to maintain these two conditions, much time and effort are saved in the later stages, when it is much more difficult to correct misalignment. And that is where the value of experienced supervision on a deep foundation job exhibits its greatest value.

New Orleans Bridge piers

The piers for the New Orleans Bridge now under construction fall within the category of major deep foundation work. This structure calls for superlatives both as to depth and size of piers, and especially as to the length of the cantilever span. With its 1,575-ft span, this structure will be the world's longest cantilever-type highway bridge. It surpasses by 175 ft the main cantilever span of the East Bay section of the San Francisco–Oakland Bay Bridge, the previous record holder. Only two other cantilever spans in the world exceed that of this new structure. Both are railroad bridges—one spans the St. Lawrence at Quebec, 1,800 ft; and the other is Scotland's Firth of Forth Bridge, with a 1,700-ft span.

The Mississippi River—by virtue of its great depth in the lower reaches, its shifting bottom, the absence of firm rock for the final foundation, and its high flood levels—automatically requires the best in bridge design and construction. The Vicksburg Bridge was the first of these lower river structures, and for it pneumatic caissons were used. The Huey P. Long Bridge, approxi-

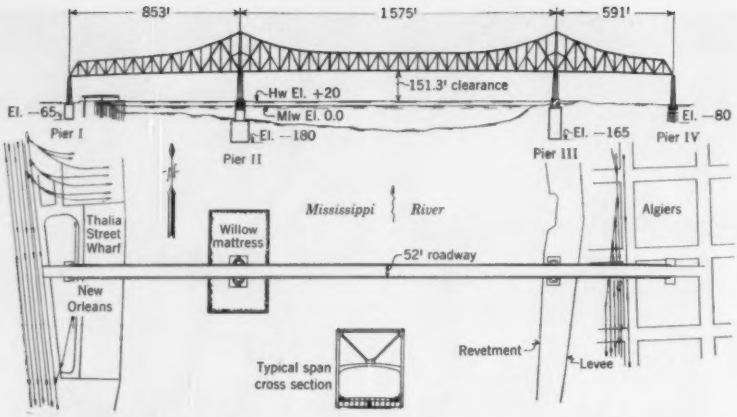


FIG. 1. Main span of 1,575 ft makes 65-million-dollar crossing of Mississippi River at New Orleans longest vehicular cantilever bridge in the world.

mately 10 miles upstream from the site of the new span, was the first to use open-dredged caissons, which were sunk through sand islands for the deep river piers. Baton Rouge was next, again using open-dredged caissons with sand islands. Natchez and Greenville were simultaneous projects, both using open-dredged floating caissons for the main river piers, and dry shoes for the shore piers. Most recent was the Memphis Bridge, with open-dredged land piers and pneumatic river piers.

On the new Mississippi River Bridge at New Orleans, the overall length of the three main spans will be 3,019 ft (Fig. 1). The main span will be supported by one main pier in the river (Pier 2), 550 ft out from the east or New Orleans shore, and by another pier (Pier 3) on the river side of the levee on the opposite shore. On the New Orleans side, the anchor pier (Pier 1) will be on the land side of the Thalia Street Wharf, with an 853-ft span from this to the main river pier. The other anchor pier (Pier 4) will be connected with Pier 3 across the levee by a 591-ft span.

Bids were taken for the four main river piers on January 25, 1955. Dravo Corporation, at $6,691,590, was the lowest of five bidders. The contractor started work on February 28, 1955, and has been proceeding steadily. Scheduled completion date for this part of the work is December 1956.

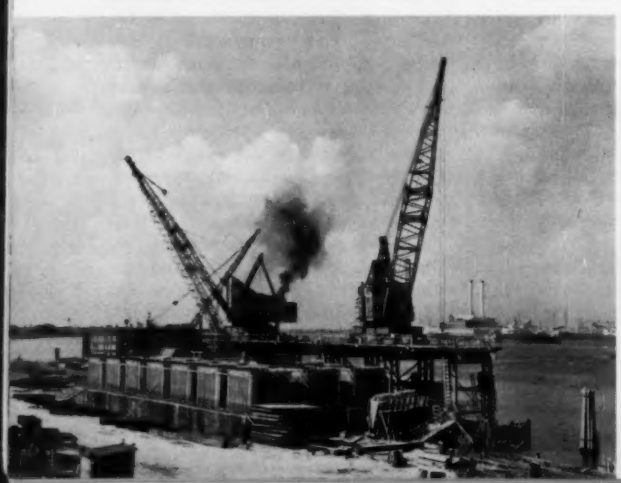
Work started immediately on anchor Pier 1. This is a land pier exposed to no particular complications from flood stages in the river. It has been sunk as an open-dredged caisson. In plan, the caisson base is 38 ft wide, 90 ft 6 in. long, and 71 ft high. Construction is cellular with 10 dredging wells, each 14 ft 6 in. square. Final elevation on compact fine sand was reached on July 24, 1955. Next came the cleaning of the working chamber by diver and high-pressure jet. Then a tremie seal of submarine concrete 17 ft thick was placed through tremie pipe, filling the working chamber completely and up into the dredging wells a distance of 9 ft. This provides foundation bearing the full size of the caisson and pier.

An 8-ft-thick concrete distributing block was placed to cover the tops of the dredging wells up to 4 ft below ground line. Two concrete shafts will rise 125 ft to a top elevation of + 138.58.

To start this caisson, a steel shoe, or cutting edge, was laid out and assembled on the pier site in conventional fashion. Wooden forms were built around the outside and for the ten dredging wells, and the concrete, heavily reinforced, was carried up to 21 ft above the cutting edge. Thereafter sinking and addition of 10-ft lifts were alternated without any special difficulty.

Anchor Pier 4, on the west or opposite side, will be approximately 400 ft back of the levee. This will be a relatively simple structure, having a base 48 ft 6 in. wide by 122 ft long and 10 ft deep, supported by 490 timber piles 80 ft long, which are now being driven. The top of this footing at El. +7 will be one foot below ground level. Two concrete shafts, similar to those of Pier 1, will be carried up 140 ft 11 in. to El. + 147.75. There is nothing out of the ordinary about this foundation.

Pier 3, on west bank of river on river side of levee, has cellular-type caisson like that for Piers 1 and 2. Construction here is seen progressing from 150-ft-long whirler trestle mounting two 30-ton whirler cranes. Sheetpiling provides partial sand-island.



To prevent scour of river bottom at site of Pier 2, Contractor sank 3½-acre willow mattress, here seen being loaded with stone in preparation for sinking. The 500-ton floating steel caisson will knife through mattress on its descent to depth of 110 ft below river bottom.

On the other hand, Pier 3 on the west bank, immediately in front of the levee, presents an interesting problem. The base is 61 ft 6 in. wide by 135 ft 6 in. long for the bottom 20 ft, at which point it steps in 6 in. for the entire periphery of the pier. Its height is 157 ft, founding at El. −165 on stiff gray clay. This caisson, in common with that for Piers 1 and 2, is cellular. It has 21 dredging wells, each 14 ft 6 in. square. In addition to the main cutting edge, there are two intermediate transverse cutting edges which divide the 4,200-cu yd tremie seal into three separate pours. As the ground line is at El. +10, and the top of the caisson will be at El. −8, an attached cofferdam of 6-in. tongue-and-grove sheeting, internally braced with structural steel, will follow the outline of the caisson to above ground line. The 10-ft-thick distributing block spanning the wells will bring the top of the footing to El. +2. A single pier shaft, stone faced with rounded ends, will rise from El. +2 to El. +30. Above this, two concrete shafts will rise to El. +161.5.

To construct this pier, a 150-ft-long whirler trestle on the river side carries two all-steel, 30-ton-capacity, completely revolving whirler cranes with a rail circle of 17-ft diameter. Crane rails are at El. +30. The trestle is supported by 32 steel bearing piles 160 ft long, driven to an elevation of 30 ft above the final planned cutting edge of the caisson.

Between the trestle and the pier site, a single row of arch-web steel sheet-piling supports a shell fill to provide a semi "sand island." Here in the dry the caisson shoe was assembled, formed,

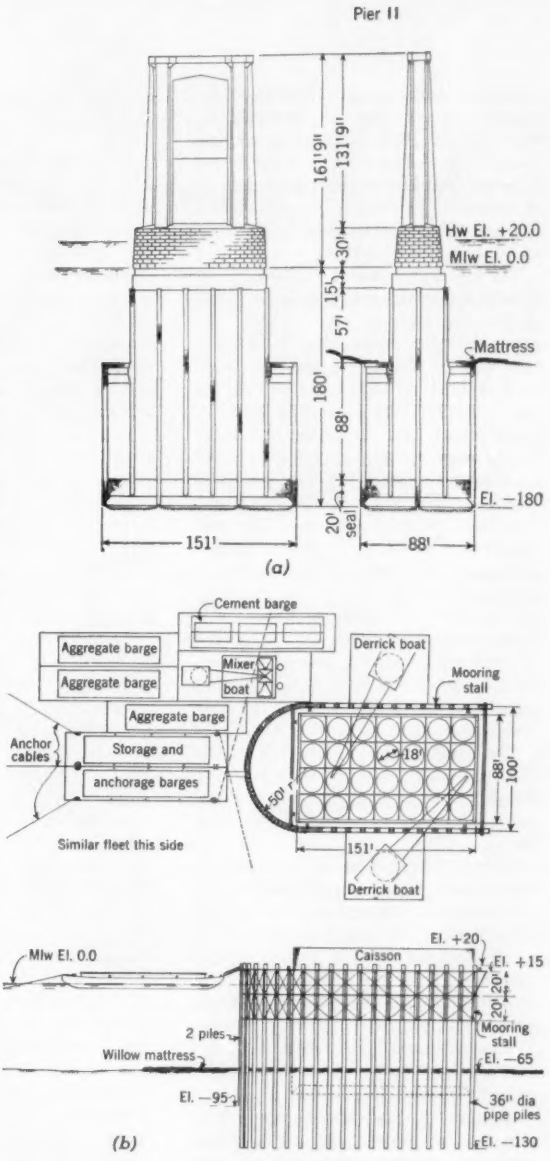
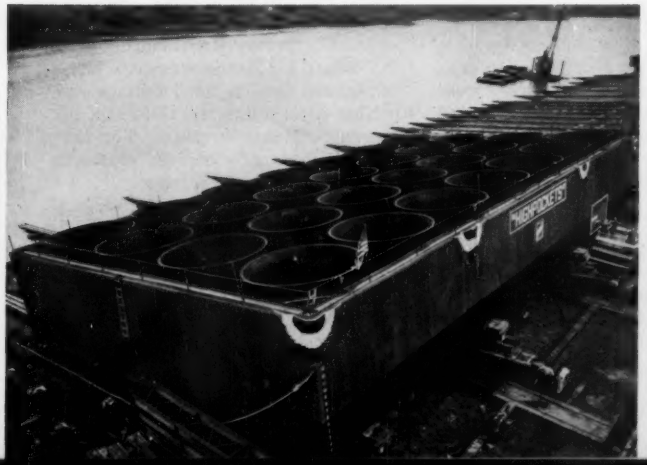


FIG. 2. Pier 2, shown in (*a*) is only river pier, and construction of its foundation is major feature of project. After willow mattress had been sunk, mooring stall shown in (*b*) was positioned and anchored, leaving one end open to receive caisson, shown in position in plan. Both mooring stall and caisson were fabricated at contractor's shipways at Neville Island, Pittsburgh, Pa., and towed 1,900 miles to site.



Caisson for Pier 2 foundation stands ready for launching at contractor's Neville Island ways. In unusual ceremony, non-self-propelled "vessel" was christened *Highpockets*. It is 88 ft by 151 ft by 20 ft high, and its 28 wells have diameter of 18 ft. See also cover photo.

Floating caisson has been moved into mooring stall by barge and downstream end (foreground) has been closed.

concreted, and sunk in much the same manner as at Pier 1. Progress to January 15, 1956, resulted in sinking 140 ft to El. −130, with 35 ft yet to go. This caisson will require 26,000 cu yd of concrete. Alternate concreting and sinking will progress steadily into the spring or summer of 1956.

The key unit on the job is Pier 2 (Fig. 2), which encompasses practically every challenging problem met with on the most difficult underwater foundation projects. A floating caisson is being used on this, the only river pier on the job. It is 550 ft out from the New Orleans wharf and altogether too close to the main navigation channel for the contractor's peace of mind. Consideration had to be given to the vulnerable condition of the caisson while still afloat and of the fleet of construction equipment surrounding it, since ocean freighters and river tows move upstream and down at all hours of the day and night, in all sorts of weather. In view of these difficulties, as well as the swiftness of the current, it was necessary to schedule construction during the low-water season.

The caisson base is 88 ft × 151 ft in plan below El. −72 (or river bottom). Mean low water is at El. +2, and the caisson will be founded at El. −180 on stiff gray clay.

The first operation at the pier site was to sink a willow mattress 300 ft × 500 ft in area (about 3½ acres) to prevent scour. The mattress was woven at Plaquemine, La., of sturdy willows cut from 150 acres of river bank land, trimmed and laced firmly together on previously prepared launching ways. Heavy wire and steel cables insured a unit that would stand the terrific stresses experienced during sinking.

Towing the mattress to the bridge site was no small task. After being centered approximately over the pier location, it was held in place by cables and anchors. Sixteen headline anchor cables about 1,200 ft long extended from concrete blocks in the river bed to the mattress and the mooring barges across the upstream end of the mattress. These barges, together with others along both sides and the downstream end acted as a temporary supporting "frame," secured to the mattress with manila lines. Lateral cables to side anchors steadied the mattress in its position while three tail anchors downstream counteracted the tendency of the upstream cables to sag and pull the mattress out of position.

The next step was to distribute the ballast of one- and two-man stone over the entire area of the mattress. When it was loaded sufficiently to overcome buoyancy, the lines to the mooring barges were slacked off carefully, so as to allow the mattress to settle to the river bed.

After the mattress was in place, a stall—actually a steel U-shaped barrier or fence (Fig. 2*b*)—was placed around the pier site to hold the floating caisson steady while being sunk to the river bed. The rigid part of this stall is 40 ft high, extending from El. +15 to −25. It is supported by thirty-nine, 36-in.-diameter steel pipe piles 150 ft long, and driven 60 ft into the river bed. These were filled with sand and gravel to provide stability and internal support against crushing.

The prefabricated units of the stall were assembled at the contractor's Pittsburgh yard and barged to the job. Putting these together, lowering and positioning in the middle of the river was a relatively simple task, but it did require careful planning and handling as well as equipment of very substantial capacity.

The upstream end of the stall was surrounded by a semicircle of steel sheetpiling, driven vertically, to cut off the current. Vertical guide beams were then driven into the river bottom on both sides and across the upstream end to hold the caisson in exact location.

In the meantime, the floating base for the caisson was being fabricated and assembled at the contractor's Neville Island yard, about 7 miles down the Ohio from Pittsburgh. This is an all-welded, water-tight box carrying the heavily reinforced cutting edge.

The "floater" was launched on August 12, 1955, accompanied by certain ceremonies which are ordinarily reserved for a self-propelled vessel. It was christened *Highpockets* in honor of the contracting firm's retired Senior Vice President J. S. Miller, who for many years headed its heavy and marine foundation work. The nickname of *Highpockets* was fastened on him by construction men working under his supervision in his early days on this type of work.

Highpockets was towed 1,900 miles down the Ohio and Mississippi Rivers to New Orleans. On arrival, it was moored securely to the dock, while 27 ft of attached cofferdam and dredging tubes were added, with necessary concrete ballast to provide greater freeboard above water level before towing out to the more hazardous location of Pier 2.

On October 14, with the attached cofferdam and dredging tubes carried up to 47 ft above the cutting edge, three towboats moved the ungainly monster out into the river. It was maneuvered carefully into the open downstream end of the stall and snugly against the vertical beams already in place at the upper end and on both sides. The downstream "gate" was closed with a horizontal beam, and the two downstream vertical guide beams were driven, thus providing a vertical "slot" in which the caisson is held firmly—free to move in a vertical direction only.

From this point on, until the cutting edge reached the river bottom, the work consisted of the repetition of two main operations. First concrete was placed between the attached cofferdam and the dredging tubes, sufficient to sink the caisson to the limit of safe freeboard. Then another unit of attached cofferdam and dredging tubes was added. On November 19, 1955, the caisson was firmly landed on the bottom. Excavation through the dredging tubes with clamshell bucket was then started.

The same procedures used on the shore piers are being utilized at Pier 2, that is, alternate dredging and concreting until the caisson reaches final elevation. Of course, on the river pier, the attached cofferdam must be extended step by step above the water level until sufficient penetration has been achieved to permit carrying the top of the concrete above the water level, at which time the attached cofferdam will be dispensed with.

By January 15, 1956, concrete had been carried 80 ft above the cutting edge, and this edge was 30 ft below the river bottom with 80 ft still to go to reach founding level 110 ft below the river bottom.

Free jets, carried down the dredging wells, are being used when necessary to loosen material beneath the cutting edge. Such jets will be used to clean out the bottom of the caisson when it reaches final grade. Water levels inside and outside the caisson are kept equalized at all times. The caisson will never by pumped out except in the area between the attached cofferdam and the dredging wells, where minor leakage through the attached cofferdam will be removed as necessary. When the caisson finally reaches founding level and has been cleaned out, a submarine seal of 6,800 cu yd of concrete will be placed through tremie pipes, using two mixer boats as a source of supply. In addition to the peripheral cutting edge, the caisson has one intermediate longitudinal and two intermediate transverse cutting edges, which will divide the 21-ft tremie seal into six pours. This caisson will eventually contain 35,000 cu yd (70,000 tons) of concrete.

After sealing, a 10-ft-thick distributing block will cover the dredging wells from El. −15 to −5. A single pier shaft, stone faced with rounded ends, will rise from El. −5 to El. +30. Above this, two concrete shafts similar

(*Continued on page 104*)

Rigid-frame failure

raises questions as to standard design assumptions

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The failures in concrete rigid frames here reported involve areas of structural behavior not yet completely understood. This study, it is hoped, will further extend our knowledge of reinforced concrete structures.

On August 17, 1955, the collapse of about 4,000 sq ft of roof at the Special Air Materiel Command (AMC) Warehouse at Wilkins Air Force Depot in Shelby, Ohio, followed a series of difficulties at other locations where the same warehouse design had been site adapted by several different reputable local architect-engineers from standard plans prepared by the L. P. Kooken Company of Baltimore, Md., for the Office of Chief of Engineers, Department of the Army. Despite the relatively small area involved, all construction on new warehouses of this type was temporarily stopped immediately following this collapse and the Corps of Engineers began an intensive investigation of the causes of the failure. As a result of this investigation, it was possible to resume construction by October 14, 1955, with a revised design and to start the application of remedial measures to previously completed warehouses by December 15, 1955.

The collapse at Shelby originated in a diagonal tension failure in the frame girder at Bent 1 of Bay 6 (Fig. 1). Failure occurred about 1 ft 6 in. beyond the cutoff point for the negative reinforcing as shown in Fig. 2. The computed dead-load moment at this point was small and of positive sign. The frame in which the collapse was initiated had been poured on February 10, 1954, and no cracks had been reported until August 3, 1955, when timber cribbing was placed under the cracked girder.

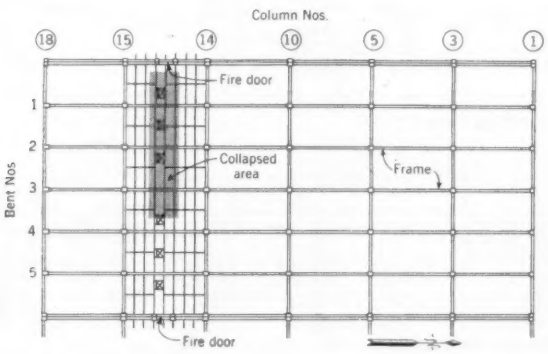
On August 17, 1955, the collapse took place in Span 14-15 in the following order:

1. Frame 2, about 22 ft from Col. 15
2. Frame 1, about 20 ft from Col. 15
3. Frame 1, collapse of cribbing at original crack 21 ft 6 in. from Col. 14 at top
4. Frame 2, about 22 ft from Col. 14
5. Frame 3, about 20 ft from Col. 15
6. Frame 3, about 22 ft from Col. 14

An observer states that the entire collapse occurred within 30 seconds and without previous warning. The failures which occurred on August 17 all showed effects of torsion and are believed to be secondary failures. The plane of the failure in Frame 1 which occurred near Col. 14 on August 3 was normal to the girder axis.

Description of warehouse structure

The warehouse is made up of ten 400 × 200-ft units. In each unit five 6-span cast-in-place reinforced concrete continuous frames, 400 ft long and 33 ft on centers, carry the roof except at the transverse expansion joints, where short-span frames are used. At Wilkins Air Force Depot, these frames support prestressed-concrete-block roof purlins spaced 8 ft $3^5/_8$ in. on centers, over which was poured a 4-in. gypsum slab with wire mesh and steel rails spanning between purlins. At other bases reinforced concrete purlins and short-span channel slabs or channel slabs of 33-ft span were used for the roof deck. One longitu-



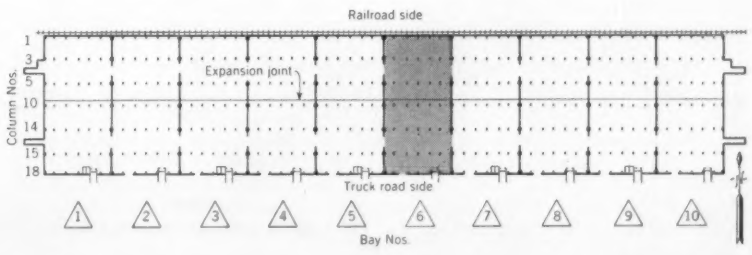
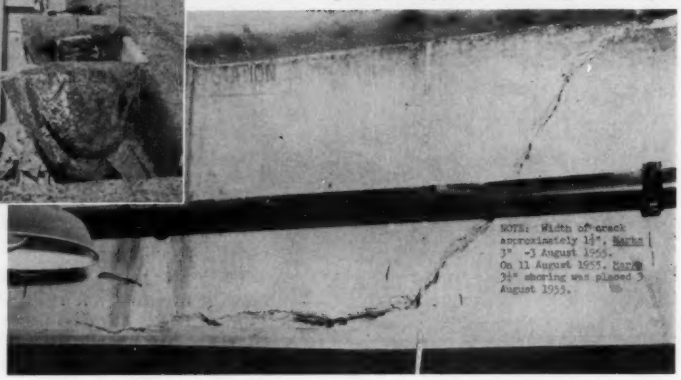


FIG. 1. Collapsed area in Special AMC Warehouse at Wilkins Air Force Depot, Shelby, Ohio, is in Bay 6. All bays are identical, with five bents, as shown in detailed plan of Bay 6, above.

Collapse of about 4,000 sq ft of roof at Special AMC Warehouse at Wilkins Air Force Depot led to intensive investigation of causes of failure. Standard design was revised and remedial measures applied.



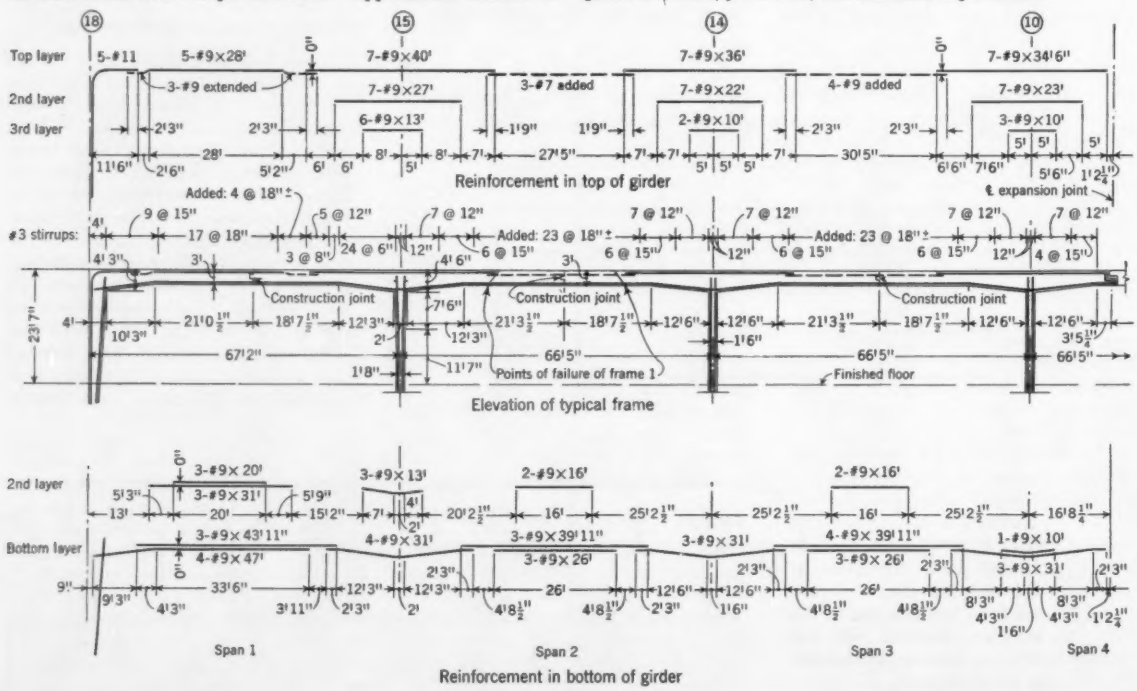
Rigid frame of reinforced concrete, 400 ft long, failed about 1 ft 6 in. beyond cutoff point for negative reinforcing. See Fig. 2.

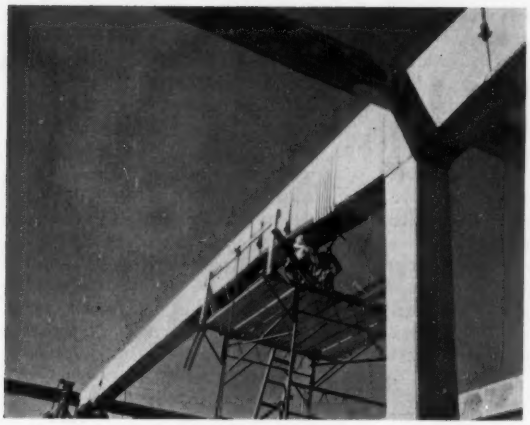
dinal expansion joint runs the full length of the building near mid-width.

At the direction of the Office of Chief of Engineers, Ammann & Whitney representatives visited the Wilkins and two other depots at which Air Materiel Command Special Warehouses had been completed in the previous 24 months. Some of the warehouses had been built from the original plans without modifications; others had been strengthened by the addition of all or part of the longitudinal steel and stirrups shown in Fig. 2. The field inspection showed that the failure in Bay 6 at Wilkins was not the result of an isolated weakness but of a general condition which was evidenced by extensive cracking in many of the frame girders. The largest and most dangerous cracks were found to occur in the regions of low moment near the points of contraflexure. The tops of the cracks are located near or just beyond the points where the negative moment steel is substantially reduced in area or stopped completely. However, at some of the warehouses and other structures of similar type, large cracks have also been noted in the negative-moment region closer to the columns.

The cracks generally follow diagonal failure planes making angles of less than 45 deg with the vertical. The details of the cracks themselves vary. Some are larger at the bottom, others at the top. There are indications that some

FIG. 2. Reinforcing in typical frame of Special AMC Warehouse at Wilkins Air Force Depot is shown. Approximate location of failure in Bay 6 is marked on elevation, near center. Width of girder is uniformly 1 ft 8 in., and minimum depth is 3 ft.





Rigid frames already in place are being strengthened by addition of external stirrups. These are new type of high-strength galvanized steel straps 2 in. wide and 0.05 in. thick, pretensioned to 40,000 psi.

TABLE I. Comparison of normal allowable stresses

Factor	ACI 318-51	British Standard	French MRU-47	Swiss SIA-161	German DIN-1045
f_c . . .	0.45 f'_c	0.42 f'_c	0.42 f'_c	0.41 f'_c	0.47 f'_c
v_c . . .	0.03 f'_c	0.038 f'_c	0.021 f'_c	0.024 f'_c	0.037 f'_c

f'_c = 28-day cylinder strength
f_c = allowable compression in flexural members
v_c = allowable nominal shear stress = $V/(bjd)$

Note: This comparison of allowable stresses is only approximate because of national variations in methods of field control, laboratory techniques, etc. The values given are for average concrete with a compressive strength of about 3,000 psi. The cube-to-cylinder conversion factors were taken as 0.8 for 6-in. cubes and 0.85 for 8-in. cubes.

of the cracks near the point of inflection started at mid-depth and progressed either up or down depending on the local stress condition.

At each building cracks appear more prevalent in certain spans than in others even where the reinforcement is similar. However, it was noted that the cracking was not confined to the span in which it was most prevalent. At Wilkins AFD and certain other sites, cracks are much less frequent in frames where continuous top reinforcement and nominal stirrups are present throughout. In other cases, serious cracking is present even with the added reinforcement. One effect of reinforcing the region of low moment appears to be to move the critical area back into the negative-moment region near the columns.

Original design

The original design, for a 20-psf live load, has been carefully reviewed and found in general accord with the requirements of current building codes.

The original design conditions were as follows:

Vertical loads. Live load, 20 psf (uniform only, not placed for maximum effect).
Volumetric effects. Temperature change, ± 50 deg F ($\epsilon_T = 6 \times 10^{-6}\ \Delta T$); shrinkage, $\epsilon_S = 0.0002$.
Allowable stresses. f'_c = 3,000 psi, f_c = 1,350 psi, v_c = 90 psi (excess only to be taken by web reinforcement), and f_s = 20,000 psi. An increase of 25 percent was allowed for vertical loads in combination with volumetric effects.
Boundary conditions. Columns hinged at top of footings and sidesway not prevented. Coefficient of friction at hinge = +25 percent or 0 percent.
Extension of reinforcement. 12 to 24 in. beyond the point where it is no longer needed for moment due to vertical loads only.

The calculations and plans were checked and found to conform to the criteria listed above. It should be noted that, possibly except for the absence of placing the live load in patterns for maximum effect, these criteria conform to the minimum requirements of the generally accepted building codes in this country.

In addition, as a result of experience during the construction program, the Office of Chief of Engineers revised the plans in the spring of 1954 to provide continuous top bars and nominal stirrups for the full length of the frames. (See "added reinforcement," Fig. 2.) Although the addition of such nominal reinforcement is generally regarded as a desirable and conservative practice, the cracking which has been observed in frames with this revised reinforcement indicates that this does not eliminate the basic difficulty in structures of this type.

Materials and construction

Cores for compression tests, beams for flexural tests, and pull-out test specimens were taken from the collapsed spans and tested at the Ohio River Division Laboratories at Mariemont, Ohio. Results indicate that the strength of the concrete and reinforcing steel generally exceeded the minimum requirements of the specifications. The lowest value of compression strength was 3,455 psi and came from the core taken from the top of the beam near the initial failure. The other six cores were crushed at stresses from 4,015 to 5,240 psi. Moduli of rupture and bond strengths were more than adequate for the stresses computed by usual design procedures.

At Shelby, Ohio, each frame girder, 400 ft in length, was placed in a single pour during one working day. Construction joints were made by use of steel plates set at the center of each span prior to the pour. However, the pour was continuous across the plate joint, and the usefulness of these joints is doubtful. The length of the continuous pours would tend to aggravate the effects of shrinkage. At other sites the sequence of placing varied widely and was generally more favorable.

Steam curing was used during cold weather (below 50 deg F) and curing compound during warm weather (above 50 deg F). (Although the effect of the curing cannot be separated out, it may be noted that the frames poured in the colder weather were later exposed to a relatively sudden temperature drop, and cracking at Shelby appears less severe where the concrete was placed during warm weather. At other sites normal placing and curing procedures were used.)

Cement and aggregates used for construction were in accordance with the applicable federal specifications. At Shelby, the concrete mix had a cement factor of 517 lb per cu yd ($5^1/_2$ bags per cu yd) Average proportions by weight were 1:2.24:3.89. Maximum size of coarse aggregate was 1 in.

Results of investigation

In evaluating the available data to find the factors responsible for the cracking and failures, it became evident that the problem was not that of several unrelated failures, each the result of local conditions. Rather, any rational explanation of the failures must be based on unfavorable conditions which were consistently present at all the sites. Working on this premise, the following items were considered:

1. Crack details and patterns. Although at each building the cracks are more prevalent in certain spans,

they also appear in other spans in the same building. Although serious diagonal cracks are present in regions of substantial negative moment, most of the dangerous cracks are in regions of low moment. This would indicate that the failures are a result of a stress condition which is more or less typical of all spans and that circumstances associated with the sequence of placing the concrete, methods of curing and decentering, variations in concrete strength, etc., tend to develop a general pattern at each particular warehouse. Once a crack has opened at any point of a frame, the stresses may be relieved and the formation of new cracks inhibited, at least temporarily.

2. Possible "freezing" of expansion plates. There is circumstantial evidence that very high friction forces were developed between the upper and lower expansion plates. Many plates show no indication of relative displacement since installation. Stress cracks in the concrete at the supports of the expansion plates imply a high longitudinal force in addition to the vertical forces. On the other hand, some plates have been displaced. This displacement, however, may have occurred before the roof deck was placed and all motion may have been inhibited thereafter. The evidence on this point is not yet conclusive and requires a more detailed correlation between plate movements and cracking.

At one warehouse a few joints were separated vertically in order to check the possibility that horizontal displacements would occur when the restraints were removed. Magnitudes of the observed motions were very small. It is expected that additional observations during installation of remedial measures will provide information with which to evaluate the importance of this effect.

3. Delayed cracking. Cracks generally did not develop until a considerable time after the full deck load was in position. According to field reports, new cracks are still developing and enlarging. This would indicate that a time effect is present, reducing the apparent strength under long-time loading and introducing considerations of shrinkage and creep, as well as possible differential volume changes between the deck slabs and the frame girders. These factors may well be more important for the AMC warehouse frames than for other types of structures where the ratio of live load to dead load is higher. Where the ratio is high and full live load is a temporary condition, an additional factor of safety is added to the structure if long-time effects are critical. Thus it might be anticipated that the cracking in warehouses designed for a 40-psf roof load would be less severe than for the 20-pfs designs. This is confirmed by crack patterns for the warehouse at Griffiss Air Force Base in New York State.

4. Type of construction. The type of structure may be described as a free-standing frame without an integral slab. Although no conclusions can be drawn as to the effect of the type of structure simply by comparing the various AMC warehouses, comparison with other structures may be enlightening. Examples of similar failures near the points of contraflexure at low shear are available. One is a rigid-frame bridge model tested at the University of Illinois in 1938. Another is a two-span bakery roof which failed in 1954. A hangar built in 1943 and consisting of nine rectangular reinforced concrete frames, each having seven 130-ft spans, shows extensive cracking similar to that found in the Special AMC Warehouses. Examples of other structures of similar design which are similarly cracked but have not collapsed have been reported.

5. Laboratory tests. Early laboratory tests to determine shear strength of concrete beams were based on the assumption that the capacities of the member under shear and moment were independent. Most of the test specimens had low ratios of "shear span" to depth, and/or high ratios of longitudinal steel in order to prevent flexural failure prior to shear failure. One of the effects of these conditions was to give apparent strengths which are too high and not actually applicable to the full-scale member. More recent tests indicate that much lower strengths may be obtained with larger ratios of "shear span" to depth.

Prior to this time no controlled laboratory tests were available which gave reliable data on the shear strength near the point of contraflexure of continuous members. For this reason it was necessary to base any evaluation of strength on the stresses present at the failure sections in full-scale structures, such as those cited above, for which records were available. Current tests by the PCA on warehouse models verify the action of these structures qualitatively. Quantitatively the low failure strengths of the full-scale structures have not yet been duplicated. Additional tests including axial tension are expected to be helpful in this respect.

6. Building codes. There is no generally accepted theory of the actual mechanics of "shear" failure of ordinary reinforced concrete flexural members. Because of these failures and information obtained from current studies on diagonal tension in concrete beams, there is reason to believe that the design criteria for shear, as given in the current United States codes, is inadequate, and that the "shear" strength of full-scale continuous rectangular beams without monolithic slabs is much lower than had been previously thought possible, particularly where axial tension is also present.

It is also believed that in regions of low moment, a diagonal tension crack, once initiated, may progress slowly to failure. If this is the case, then the failure load is equal to the cracking load. For reasons which are not completely understood by the profession, but which may be related to the added cross-sectional area, to creep, to possible lateral confinement of the main beam, to load redistribution, and to effectiveness of slab steel, continuous beams with substantial monolithic slabs appear to have greater inherent strength than similarly designed isolated members. Certainly the nominal shear stress, $v_c = \frac{V}{bjd}$, cannot be considered to be an accurate index of the actual shear strength, which is a function of the axial force at the section, the amount of longitudinal reinforcement, the span-to-depth ratio, the flexural compression-to-shear ratio, and the shape of the cross section as well as the compressive strength, f_c'.

Remedial measures

Plans and specifications have been prepared for strengthening of all existing frame girders by the addition of external stirrups to carry the full dead load from a point 3 ft toward the center of the span, from the extreme location of the point of inflection, to within 4 ft from the face of column. Where the cutoff point for the upper layer of positive reinforcement falls outside this region, the calculated stirrups are continued at least two spaces past the cutoff.

The girders will be jacked vertically and shored to reduce, as far as possible, dead-load stress prior to the stengthening operation. The possibility of separating the bearing plates at the expansion joints and jacking horizontally to minimize axial tension is also being considered.

The external stirrups are of a new type and consist of high-strength galvanized steel strapping 2 in. wide by 0.05 in. thick, pretensioned to approximately 40,000 psi. The specifications call for a minimum yield point of 70,000 psi and a breaking strength of 100,000 psi. The nominal working stress is 52,000 psi. Although external stirrups have been used in the laboratory and for repair work, this is the first application of high-strength steel strapping for this purpose. The strapping is similar to that used on crating, etc., for shipping purposes, and is available from several manufac-

turers. The strapper which has been found most effective thus far is a worm-gear type, model W2, manufactured by the Signode Company, and modified to give a good control of the strap tension. It is anticipated that in most cases these straps can be installed without removal of the roof.

Where the reinforcement is not in accordance with the OCE Revision of March 1954, heavy angles are placed at the lower corners of the girders in the regions around the points of contraflexure, and lighter angles and straps at a spacing of 15 in. are continued to the center of the span. The straps and angles may remain exposed or may be fireproofed.

The compression resulting from pretensioning the strapping serves three purposes. First, it induces a compression in the concrete which tends to balance any internal tensions which may exist, thus raising the magnitude of the allowable cracking load. Second, in the event a crack does occur, the angle between the crack and the horizontal is reduced, thus bringing more straps into action. Third, the size of the crack is kept to a minimum. Under dead load no new cracks will open, and it is anticipated that those now open will tend to close. Under overload the opening will be determined by the increase in the strap tension. Since the strap is not bonded to the concrete, this is of prime importance, the crack opening being due not to the unit strain in the strap, but to the elongation over its entire length. The effectiveness of the pretensioned straps has been verified by recent tests.

The possibility of using pretensioned high-strength wire strand, straight and/or draped, to introduce axial compression and to reduce the vertical shears carried by the girder was also studied—and abandoned because of the many uncertainties involved.

Redesign for new construction

The following steps have been taken to ensure that all new construction will be fully adequate:

1. Web reinforcement has been designed to carry the entire shear in the region of low moment without help from the concrete. This region is defined as being located between points 3 ft either side of the extreme positions of the points of contraflexure at each end of the span, including the volumetric effects and 50-percent unbalanced live load. The minimum stirrup spacing was then continued to the face of supports. Because of the increased depth at the haunches, the web reinforcement in this region is also adequate for almost the full shear. In order to avoid an abrupt change in stirrup spacing, the web reinforcement was designed for $^2/_3$ of the total shear in the central portion of the span between the regions of low moment. The minimum spacing of stirrups or ties which cover the full width of the beam was set at 20 in. with partial-width stirrups halfway between. The stirrups are rectangular ties spliced in the compression zone where possible and also bent around the longitudinal steel.

2. A combination of self-lubricating bronze and stainless-steel rocker and expansion plates has been substituted for the original structural steel bearings in order to reduce the possible longitudinal force caused by friction to a tolerable minimum.

3. The area of longitudinal steel has also been substantially increased in critical areas by computing the effects of non-uniform live load and a more detailed analysis of shrinkage and temperature effects.

4. The amount of continuous longitudinal steel has been increased to 0.005 *bd* on the top face and on the bottom face. (This provides for variation in the locations of the points of inflection due to conditions not included in the calculations, and for possible longitudinal forces.)

5. Two continuous No. 5 bars have been added on each vertical face to control local cracking.

6. The concrete supports for the expansion plates have been strengthened by deepening the sections and revising the reinforcement.

7. The center-to-center spacing of the longitudinal steel has been increased to facilitate placement of the concrete and to avoid the possibility of reduced effective bond between the concrete and the bars.

8. Splices and cutoffs were staggered as much as practical.

To minimize the cost of strengthening the design for those cases where the reinforcing steel had already been fabricated, drawings were prepared to utilize the existing steel to the maximum extent. It has been possible to avoid wastage almost completely.

Laboratory tests are being conducted by the Portland Cement Association at Skokie, Ill., in cooperation with the OCE to verify the strengths of the various designs and the remedial measures.

To verify the results of this investigation, to correlate the laboratory tests with the prototype under actual field conditions, and to ensure that a reasonable factor of safety is present in the prototype, it is planned to perform a carefully detailed and controlled load test on one frame built from the original plans after installation of the recommended remedial measures. It is also planned to instrument a frame to be built from the new design in order to verify long-time shrinkage, temperature and permanent load effects in full-scale structures.

European building code requirements

It was considered desirable to review the requirements of the building codes of other countries with respect to web reinforcement and allowable concrete stress. It was found that the British, French, Swiss, and German codes did not differentiate between beams having monolithic slabs and those which are isolated rectangular members. All the European codes require that web reinforcement be designed for the full shear where the allowable concrete diagonal tension stress is exceeded. In addition, the German code requires that if the nominal shear stress anywhere in a half span exceeds the allowable value, all the shear in that half span is to be taken by web reinforcement.

From Table I it would appear that current allowable stresses in American building codes do not vary radically from those in other countries, and that, except in the case of the German specifications, computed web reinforcement would not have been required at the point of failure. However, it should be noted that all the European codes recommend nominal stirrups, and bending up as much of the longitudinal steel as practical and consistent with bond and anchorage requirements, regardless of the computed shear stress. On the other hand, most European countries do not make use of deformed bars.

Proposed revisions to Building Code

As a result of accumulated laboratory and prototype experience, appropriate technical committees of the ACI have recommended revisions to the ACI Building Code to limit the allowable nominal shear stress to 90 psi for $f_c' \geq$ 3,000 psi, and to include the following paragraphs:

801 (*d*). When the value of the shearing unit stress computed by formula (12) exceeds the shearing unit stress, v_c, permitted on the concrete of an unreinforced web (see Section 305), web reinforcement shall be provided to carry two-thirds of the total shear at the section or the excess, whichever is greater.

801 (*e*). In continuous or restrained beams or frames, except T-beams with integral slab cast monolithically, web reinforcement shall be provided from the support to a point beyond the extreme position of the point of inflection, a distance equal to either one-sixteenth of the clear span or the depth of the member, whichever is greater, even though the shearing unit stress does not exceed v_c. Such reinforcement shall be designed to carry at least two-thirds of the total shear at the section. Web reinforcement shall be provided sufficient to carry at least two-thirds of the total shear at a section in which there is negative reinforcement.

807. Where web reinforcement is required, the amount used shall be not less than 0.15 percent of the area computed as

the product of the width of the member at mid-depth and the horizontal spacing of the web reinforcement.

The proposed revisions are empirical and are intended to prevent any future failures in this type of structure without unduly penalizing other types of structures which have demonstrated their adequacy by years of service. This is a field in which much research is under way and much additional research is required. The failure of the Special AMC Warehouse has demonstrated the urgency of the problem.

In considering these code revisions, it should be noted that thousands of satisfactory structures have been built under each of the codes listed in Table I. Although there is always a tendency to be "on the safe side," as in the case of the German code, and provide full web reinforcement throughout, this procedure would have resulted in the expenditure of millions of dollars for additional web reinforcement in most structures built since 1925, when the German code was adopted. All the design methods, American and European, are empirical and result from varied interpretations of similar test data. In addition, the various codes reflect local conditions and the relative costs of labor and material.

It is believed that the experience gained from this failure and the subsequent investigations will result in improved design techniques with which the generally excellent record of reinforced concrete structures may be further extended.

The cooperation and aid received from the Office of the Chief of Engineers, the various Division and District Engineers, the consultants to the Office of the Chief of Engineers, and the Portland Cement Association, are gratefully acknowledged.

The investigation on which this article is based was performed by Ammann & Whitney, Consulting Engineers, under Department of the Army Contract No. DA 49-129-eng-351, under the supervision of Paul D. Troxler, M. ASCE, Colonel, Corps of Engineers, Assistant for Engineering and Contracts; H. B. Zackrison, Sr., Chief, Engineering Division; and William Schaem, A.M. ASCE, Assistant Chief, Structures Branch, Military Construction, Office of Chief of Engineers, Department of the Army.

The plans, specifications and design calculations for new construction and remedial measures were reviewed by the following independent consultants retained by the Corps of Engineers: Prof. Robert J. Hansen, A.M. ASCE, Massachusetts Institute of Technology; Prof. Nathan M. Newmark, M. ASCE, University of Illinois; and Prof. Chester P. Siess, M. ASCE, University of Illinois.

ENGINEERING ETHICS—

Practically, ethics is a way of life—the daily application of the Golden Rule. Codes of ethics have been prepared by many engineering societies for the guidance of their members. That of ASCE comprises the best features of the codes adopted by eleven engineering organizations. Since engineering ethics is essentially a set of principles governing the professional man's relationships with others, an attempt will be made here to define it in terms of four main relationships.

The engineer and his professional life.—Perhaps foremost in importance is the engineer's conduct in his professional life. The knowledge he possesses is part of a common fund built up through many generations. It is an inheritance which he freely shares and to which he is obligated to add. Hence it is his duty to publish the fruits of his research and to share his advances in professional practice. If he is unable to contribute ideas, he can contribute through his association with engineering organizations to which he pays dues or assessments. He can contribute to the work of the schools and the press.

At all times he must avoid bringing discredit on the honor or dignity of his profession. To advertise in self-laudatory language or in any other manner derogatory to the profession is considered unethical and not up to the level of conduct expected of a professional man. Under no circumstances should the engineer use influence or offer commissions to obtain professional work or otherwise solicit it improperly—directly or indirectly.

The engineer and the public.—As a professional man the engineer has responsibilities to the public and to the community of which he is so vital a part. He must endeavor to extend public knowledge of engineering and to discourage the spreading of untrue, unfair, and exaggerated statements regarding it.

Due regard must always be given to public safety, which may be affected by the work for which the engineer is responsible. Too often when pressed for time he may fail to consider all the factors which concern the public welfare. He should guard against conditions which are dangerous to life, limb, or property, and if not himself responsible, should call the dangerous conditions to the attention of those who are.

If called upon to serve as a witness before a court, commission, or other tribunal, the engineer will express opinions on engineering subjects only when they are founded on adequate knowledge and honest conviction. He will not express opinions publicly unless he is informed as to the related facts. He will not issue one-sided statements connected with public policy, inspired or paid for by private interests—except of course when he indicates in whose behalf the statements are made.

The engineer and his clients or employers.—The engineer has definite responsibilities in dealing with those individuals or groups who are his clients or employers. He must above all act as a faithful agent, keeping in confidence information given him for the purpose of enabling him to perform his professional duties, and accepting only his stated charges for the work.

Fairness and justice should always prevail in relations between the client or employer and the contractor. Too many times this responsibility is disregarded, and the engineer may seem

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can it be defined?

more concerned for his personal gain than to maintain the ideals he talks of so freely.

Should the engineer be called upon to use an invention, apparatus, or device in which he has a financial interest, he should have a clear understanding about it with his client or employer in advance.

The matter of compensation, although essential to the livelihood of the engineer, should come second in importance. It should not come before his professional aspirations and responsibilities. He should receive compensation from only one interested party for the services pertaining to the same work, except with the consent of all interested parties. He should accept neither commissions nor allowances directly or indirectly from contractors or other parties dealing with his client in connection with work for which he is responsible. Nor should he be financially interested in bids submitted by a contractor for competitive work on which he is employed as an engineer unless he has the consent of his client or employer.

In this connection cases may arise in which almost any article of the code cannot be applied rigidly, if at all. The code is intended as a set of rules so generally true that the engineer is obligated to observe them. If a situation arises which appears to be not covered by the code, the engineer should satisfy himself that it is not so covered, and that he is acting in accord with the principles of fair dealing which must govern him as a professional man.

The engineer and other engineers. Last but not least comes the engineer's relationship with other engineers. Above all else he will protect the engineering profession collectively and individually from misrepresentation and misunderstanding. Long, slow progress can be destroyed very quickly and disastrously by even an unintentional misunderstanding, and once lost may require years of effort to restore.

Give proper credit for engineering work to those to whom credit is due. It is easy at times to give the impression that an engineering project on which we may have a minor part is of our own making and responsibility.

When in a position to do so, the engineer should uphold the principle of appropriate and adequate compensation for those engaged in engineering work, including those in subordinate capacities, for it is in the public interest to maintain a high standard in the profession. This very factor has been one of the reasons why the status of the engineer has not been raised to the plane on which it rightfully belongs. The engineer himself must not be willing to accept inadequate payment for his services. Also, he should provide opportunities for the professional development of the engineers in his employ.

Once graduated from his four-year college course, the engineer must continue with his studies. To do otherwise indicates failure to recognize the rapidly changing character of the profession. Like any good product, engineering can only be improved by the study of newer methods and by keeping up with the trends of the times.

Engineers should use every precaution to avoid injury, either falsely or maliciously, to the professional reputation, prospects, or practice of another engineer. Should an engineer be guilty of unethical, illegal, or unfair practice, information pertaining to the situation should be presented to the proper authority for action. Such situations can be properly handled by the engineering societies, the engineering press, or other similar forums for professional discussion.

Further, the engineer should not attempt to supplant another engineer knowing definite steps have been taken to employ him, or to weaken his opportunity for employment by volunteering criticisms. He does not attempt to obtain work through the practice of competitive bidding on a price basis, either by bidding less than the going fee or by lowering his fee after the charges of others are known. Many engineers in salaried positions take advantage of their security to compete unfairly with engineers in private practice. Such competition is highly unethical. Here again, where the Code of Ethics does not cover a particular case, the burden rests on the individual engineer to satisfy himself that he is acting in accord with the spirit of the code.

An engineer should avoid reviewing the work of another engineer without his knowledge or consent, unless the services of the other engineer have been terminated. Under any circumstances, the review of another's work should be done in such a manner as to maintain the dignity of the profession. Only such criticisms should be offered as good judgment dictates.

The Canons of Ethics for Engineers, adopted by the Engineers' Council for Professional Development, begin as follows:

"Honesty, justice, and courtesy form a moral philosophy which, associated with mutual interest among men, constitutes the foundation of ethics. The Engineer should recognize such a standard, not in passive observance, but as a set of dynamic principles guiding his conduct and way of life."

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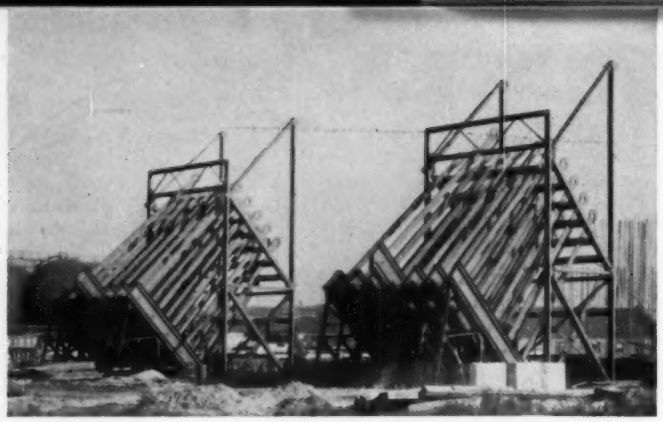
Project Engineer

Modjeski & Masters–Ammann & Whitney

Gloucester, N. J.



Another chapter in the history of suspension bridge building is being written on the Delaware River, where the Walt Whitman Bridge is being built between Philadelphia, Pa., and Gloucester, N.J. Although no longer the pioneer structures they once were, long suspension bridges still have glamour for engineers and laymen alike. This article discusses the construction of the anchorages and superstructure. The construction of the river piers was described by William L. Stone, Jr., in the August 1955 issue of CIVIL ENGINEERING, page 56. It is of interest to note that these piers, in the river, were built using sand islands and land equipment, whereas the concrete for the anchorages, on shore, was placed by marine methods and equipment.

One of the first field tasks of the engineers for this bridge, Modjeski & Masters–Ammann & Whitney, was to establish a triangulation system for the various studies involved in fixing the bridge centerline and for locating the river borings. This initial system was adequate for the purposes mentioned but was not as accurate as desired for actual construction. Therefore it was necessary, before the start of the contractors' work, to set up a precise control system.

On the Philadelphia side, the river bank was free of obstruction from the bridge site south as far as necessary to establish an entirely satisfactory baseline 2,261.79 ft in length. However, on the Gloucester side, in New Jersey, the bridge centerline was located just south of the plant of the New York Shipbuilding Corp., making it necessary to acquire land from this company which it used for steel storage. It was also necessary to acquire land leased to the Radio Corporation of America and to demolish a number of buildings which stood on it. Immediately to the south is the plant of the Armstrong Cork Company, which stores immense piles of baled cork along the river bank and usually has a freighter at the dock unloading more. Obviously a baseline along this bank of the river would have had to be very limited in length. The baseline for construction control was therefore located along Ellis Street, the first street paralleling the river in Gloucester. The north end of this line had to be referenced from a triangulation station located on top of one of the RCA buildings. The south end, in the grounds of the U.S. Coast Guard, required the construction of a tower to clear some intervening buildings.

The measured baseline, 1,995.85 ft long, was extended north to an intersection with the bridge centerline to permit checking the locations of the tower and anchorage foundations by direct measurements. A number of Corps of Engineers' monuments were tied in so as to establish the location of the pierhead and bulkhead lines. Elevations on each side of the river were established from U. S. G. S. benchmarks.

Bids for Contract No. 1, the two river piers, were taken on June 22, 1953, six bids being received. The contract was awarded to the Fehlhaber Corporation of New York with a low bid of $3,219,620. For a description of the construction of these piers, in sand islands, see the article by William L. Stone, Jr., previously referred to.

Contract No. 2, for the construction of the anchorage foundations, was awarded to Merritt, Chapman & Scott Corporation, which submitted the lowest bid of $3,400,410. Since both these foundations were located back of the shoreline, their construction was visualized as a land operation. However, as the name of the contractor would indicate, the work was largely carried out as a marine operation, the concrete being mixed in a floating plant and pumped inshore to the anchorage sites.

The foundations consist of a cellular footing 124 ft long and 144 ft wide under the front or river end of the anchorage and 202 steel-shell concrete piles under the rear portion (Fig. 1). The design of the footings contemplated their construction as caissons. The contractor, however, had recently constructed the Norfolk-Portsmouth (Va.) Tunnel, for which the Portsmouth approach had been sublet and built by a novel open-cofferdam procedure. This procedure was adopted for the anchorage foundations of the Walt Whitman Bridge.

Initially, six deep wells were driven around the site of each footing and about 25 ft out from its faces. These were used to lower the ground water within the area of the footing. This area, including a working strip about 20 ft wide on all four sides, was then excavated from El. +8 ft to the approximate level of the top of footing at El. −5 ft. This largely preempted the full width of the right-of-way on the Gloucester side and created a serious access problem for the work on the river pier. Next soldier piles 24 by 79.9 were driven approximately on 6-ft centers adjacent to the outside faces of the footing and to a depth of about 10 ft below the founding plane.

Then, as the earth inside was excavated, 3-in. timber lagging was inserted behind the inside flanges of the piles, leaving spaces between the lagging which were packed with salt hay. This was strictly a hand operation. As the placing of the lagging necessarily progressed from the top down, each piece had to be cut to such length as would permit it to be inserted between the piles with a minimum of clearance. The earth face between the piles was carefully scraped back just enough to insert the lagging. With the groundwater level lowered by the outside wells, relatively little water seeped into the excavation. Two tiers of steel wales and cross struts were installed in each cofferdam when the excavation reached the prescribed elevations. The cross struts of this bracing were supported at their intersections by steel H-beams driven well below the founding depth.

ANCHORAGES AND SUPERSTRUCTURE OF WALT WHITMAN BRIDGE

On the Philadelphia side, the plans called for founding at El. −70.0, based on information obtained from borings. Actually, by excavating in the open, permitting visual inspection of the founding material, it was possible to stop at El. −59.3. The Gloucester anchorage was founded at the plan elevation of −52.0 ft.

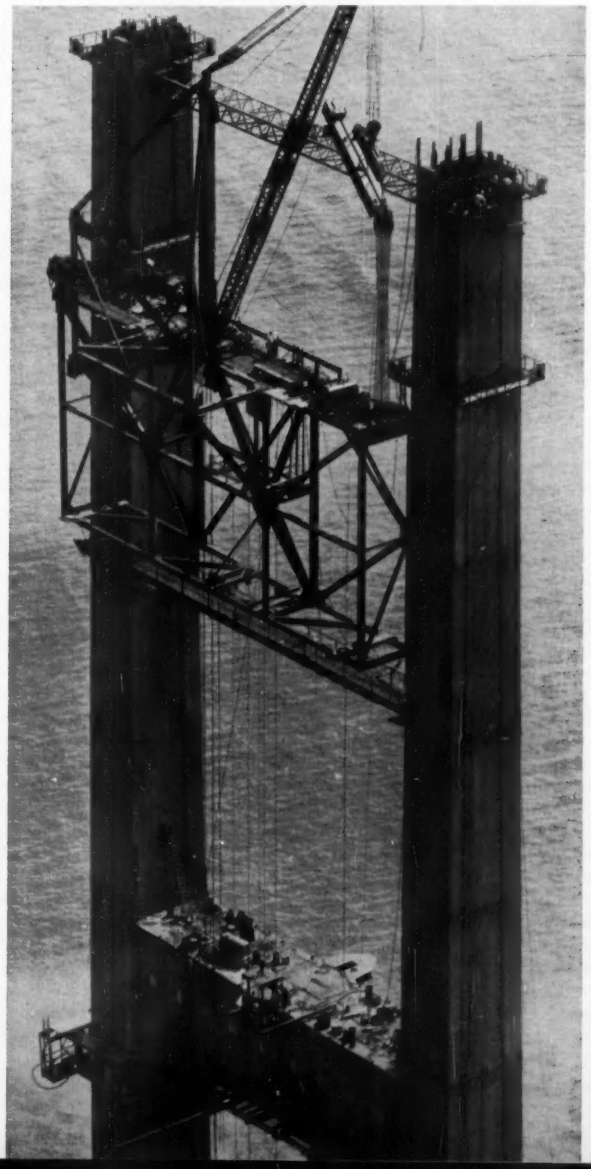
All concrete was mixed in a typical floating plant of Merritt, Chapman & Scott Corporation newly assembled for this work. Except for the revolving crane used to charge the aggregate hoppers, it was fully electrically powered from diesel generating units located at the stern of the mixer barge. The plant contained two Blaw-Knox 56-cu ft mixers mounted side by side. These discharged into 8-in. double Pumpcrete machines. The cement and aggregates were batched in manually controlled weighing bins charged from overhead hoppers. Mixing water was also batched by weight, being pumped from a storage tank in the mixer hull into manually adjusted tanks located adjacent to the weighing bins.

The cement was shipped in bulk and unloaded into enclosed barges at the Port Richmond Railroad Terminal. These were spotted in turn at the stern of the mixer barge, and the cement pumped into the hoppers with manually controlled air pumps. The sand and gravel were delivered by barge from their source near Morrisville, N.J.

The concrete was placed in the forms through "elephant trunks" which were periodically moved as the Pumpcrete lines were progressively shortened.

Corresponding to the tremie seal of a caisson, base slabs 10 ft thick on the Philadelphia side, and 9 ft thick on the Gloucester side, were constructed. On the Philadelphia side the slab was undertaken as a continuous pour totaling 6,613 cu yd. This pour began at 8:00 a.m. one Monday morning and ended at noon the following Friday. Being the

As creeper traveler approaches top of tower, spacer strut is placed between tower shafts to prevent them from leaning inward and putting pressure on traveler.



River end of each anchorage foundation consists of cellular caisson 124 × 144 ft.

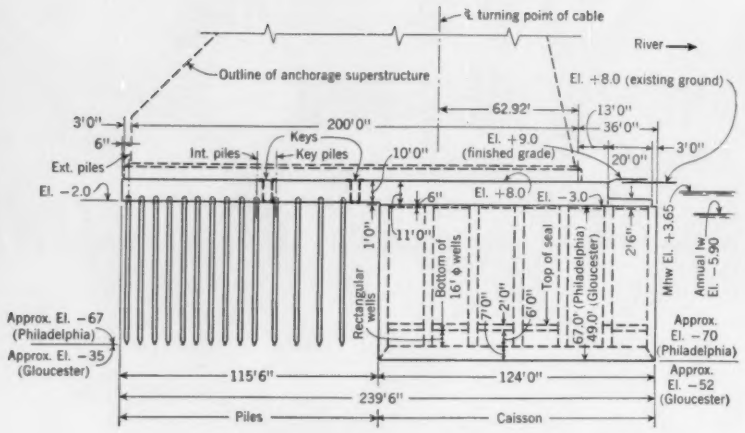


FIG. 1. Anchorage foundation consists of two types—rear part of piles and forward part (nearest river) of caisson type.

initial pour for the plant and operating crews, it proved somewhat ambitious, as during this time probably everything that could go wrong with a newly assembled plant and operating crews took this occasion to do so. As a result some of the automatic features were manually operated thereafter. Succeeding pours were materially reduced by inserting construction joints.

From the base slab to the under side of the distribution slab, circular wells were formed in the concrete corresponding to the dredge wells that would have been there had the footing been constructed by the caisson method. This, of course, was to save concrete and reduce the dead load of the footing. The wells were filled with water before placing the covers and pouring the distribution slab.

In driving the steel-shell piles forming the remainder of the foundations, it was deemed essential that the piles penetrate at least 5 ft into the underlying sand. Information disclosed during the excavation of the cofferdam on the Philadelphia side indicated that sand was at quite variable depths. Accordingly, additional borings were taken from which to develop approximate contours of the sand strata. Prejetting was used as an aid in driving the piles, and in some cases supplemental jetting beside the piles was necessary. This apparently contributed to the tendency of a number of the shells to deflect from a straight line, sufficient in some cases to require the driving of replacement shells. Load tests determined the adequacy of those not redriven.

The rest of the construction was routine and does not justify further discussion. Salvage of the soldier piles was attempted, but was given up when it was found that deep jetting would be required.

Anchorage superstructures

The contract for the construction of the anchorage superstructures, designated as Contract No. 3, was awarded to Booth & Flinn Company of Pittsburgh at an estimated cost of $3,647,075. With the exception of a granite belt course at the base, the anchorages are being constructed entirely of concrete. Each anchorage is approximately 120 ft wide by 200 ft long and 132 ft high. Buttresses at the river ends support the cable columns and saddles. Anchor girders and three tiers of eyebars for attachment of cable strands are embedded in blocks at the offshore ends. When completed, curtain walls on the sides and at each end between buttresses and anchor blocks will enclose the structures and give them the appearance of solid masses. Architectural treatment of the sides reflects the functioning of the splaying cable strands and embedded steelwork. Openings in the end walls give access to the interior of the anchorages for maintenance purposes.

Anchorages are being constructed in stages (Fig. 2). The first stage, that required to withstand the pull of the unloaded cables, is now complete.

Following the spinning of the cables, the rest of the concrete will be placed in coordination with the erection of the suspended steelwork and the construction of the roadway deck. About 20,300 cu yd of concrete were required in each anchorage for the first stage. An additional 12,400 cu yd will be needed at each anchorage for completion.

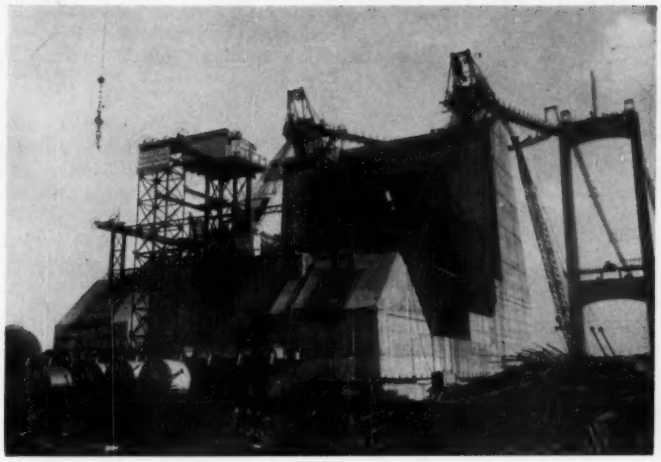
The construction procedure is essentially routine, the concrete being placed in lifts nominally 5 ft in height up to El. +53 ft, and in lifts varying from 11 to 15 ft above this elevation. Construction joints were placed in the lower lifts to reduce the size of the pours to a maximum of about 500 cu yd.

Forms are prefabricated in designed units which can be modified as they are reused for successive lifts. They are held in position by steel anchors. By specification, they are faced with rough sawn tongue-and-groove lumber, with certain areas of plywood.

Concrete for both anchorages is being obtained from central mixing plants and placed with bottom-dump buckets hoisted with cranes on crawler treads. A lift of about 125 ft was required to reach the highest pours of the first stage.

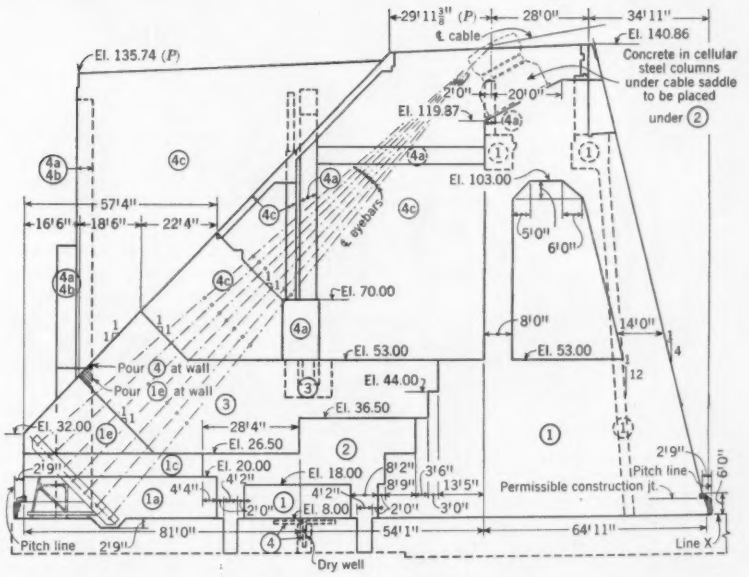
Preparations for erecting the main towers began as soon as the construction of the river piers would permit. This contract is held by the Bethlehem Steel Company, which submitted the lowest of two bids in the amount of $6,610,070.

The two main towers are 352 ft high and are formed with two tapered cellular steel shafts connected below the roadway and at the top with arched portal struts (Fig. 3). The shafts are spliced to form ten tiers varying from 9 ft 0 in. to 40 ft 10 in. in height. Generally the tiers of each shaft were fabricated in four units, two forming the river and shore faces and the other two fitting between them. The bottom tier, however, was fabricated in two units, which by virtue of the 6-in.-thick masonry plates made them the heaviest units to erect, each weighing about 66 tons. The portal struts were fabri-



Anchorage on Philadelphia side is seen ready for cable spinning, with buttresses supporting cable columns and saddles. Note cable spinning equipment assembled in left foreground.

FIG. 2. On longitudinal section through anchorage, circled numerals indicate concreting sequence. Portions designated (1a) to (1f) were placed in alphabetical sequence but without relation to timing of rest of No. 1 concrete. Next came concrete of (2). Spinning of all cable wire follows, after which concrete marked (3) and (4) will be placed in order indicated.



cated in nine units. Both towers were fabricated at Pottstown, Pa., and shipped to ground storage in Philadelphia, south of the bridge site. The shaft units forming the river and shore faces were of such size that special cradles mounted on railroad-car trucks were required to bring them within the necessary overhead clearances. Such shipments of course were special by all the rules of railroading.

The initial operation in the field was to construct a timber working platform immediately above the pier shafts, which serves also as a protection to the pier masonry. These platforms are supported on steel framing extending up from the pier distribution slabs and are of such size and strength as to support the necessary hoisting engines as well as to store fabricated tower units.

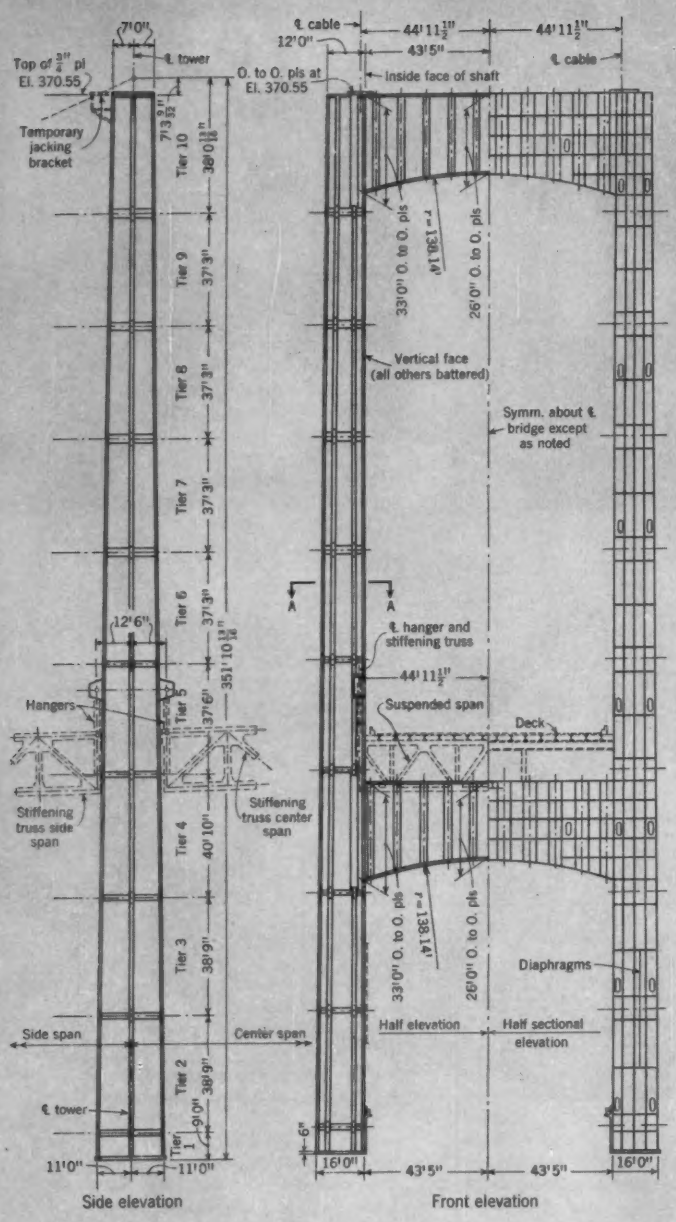
Tower sections, when needed for erection, were reloaded on cars, placed on car floats and ferried to the pier sites. Here they were unloaded by the erection derricks, and each section above the first tier was temporarily landed on the working platform with its lower end resting on a steel cradle. After the hitches had been shifted to the upper end, the section was raised to an upright position and hoisted to final location in the tower. Use of the cradle prevented damage to the milled ends of the shaft units.

The lower three tiers of the tower shafts were erected by a tower derrick mounted on tandem steel barges. This derrick in turn assembled a creeper traveler which was attached to the tower through guides engaging vertical track beams bolted to the shore faces of the tower shafts. The traveler consisted of a modified stiff-leg derrick mounted on a steel-framed cage spanning the track beams. It was designed to handle a 64-ton load at a radius of 75 ft. As each tier of the tower steelwork was erected, the traveler was raised to the next position with block and falls attached to outriggers temporarily connected to the top of the shafts. As the traveler approached its top position, a temporary spacer strut was placed between the tower shafts to maintain them at their approximately proper spacing. Spreader frames were also used in erecting the portal struts to maintain adequate clearance for inserting the closing sections.

Riveting was carried on with the usual scaffolds surrounding the tower shafts. All rivets were heated on the scaffolds and transmitted to the point of driving by pneumatic rivet passers. The contractor was permitted to place special openings in the steelwork for this purpose. To expedite the completion of the Philadelphia tower, high-strength bolts were substituted for rivets in the top portal strut and the top two tiers of the shafts. The anchor bolts were each tightened to a tension of 55,000 lb immediately after fitting up the base sections and again on completion of tower erection. Impact wrenches calibrated by the Fritz Engineering Laboratory at Bethlehem, Pa., were used for such tightening.

The base sections of the Gloucester tower were placed on December 21, 1954, and the last section of the top portal strut was erected on May 12, 1955. The corresponding dates for the Philadelphia tower were April 4, and August 16, 1955.

When erection of tower steelwork was completed, guy derricks belonging to



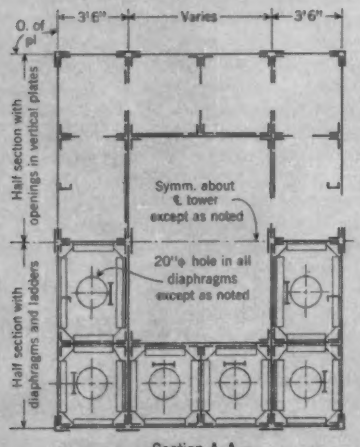

O. of pl
3'6"
Varies
3'6"
Half section with openings in vertical plates
Symm. about ℄ tower except as noted
20"ϕ hole in all diaphragms except as noted
Half section with diaphragms and ladders
Section A-A

FIG. 3. Two main towers, seen in side and front elevation and in cross section, are 352 ft high. In typical shaft, diaphragm consists of ½-in. web plate M4E and eight angles 4 x 4 x ½. Elevator is in south shaft only, and scaffold supports in north shaft only.

the cable contractor were assembled on the top portal strut for dismantling and lowering of traveler derrick and frame.

Main cables and suspenders

The contract for constructing the main cables and suspenders was awarded to the American Bridge Division of U.S. Steel Corporation at a bid price of $4,768,293.25.

The cables will be about 23 in. in diameter and will contain 37 strands of 308 wires. At each anchorage, the strands splay apart and connect to separate eyebar chains which, as previously mentioned, extend from steel girders embedded in concrete near the base of the anchorage. The connection is formed by looping the wire around spool-shaped shoes pin-connected to the ends of the eyebar chains.

The strands are being spun directly in the cable saddles, which are circular in cross section. Throughout the spans, the strands as spun and seized, are adjusted to form a hexagonal cross-section, with four strands in the upper and lower layers. The wire is nominally 0.192 in. in diameter, cold drawn in lengths of about 3,000 ft, and hot-dip galvanized. The wires are spliced with threaded sleeve couplings and placed on reels at Trenton, N.J., for delivery by truck to the bridge anchorages. Cable spinning follows the usual procedures, which basically go back to the days of John A. Roebling, M. ASCE, and his son, Col. Washington Roebling.

The footbridges, providing access for the cable spinning, are supported on lengths of wire rope which on completion of this operation will be removed and cut into shorter lengths for suspenders. As footbridge ropes, they extend from tower to tower and from towers to anchorages—three ropes for each footbridge. After attachment at the anchorages, the side-span ropes were successively hoisted with block-and-fall to their connections at the top of the towers. The main-span ropes were initially laid in pairs on the river bed from reels mounted on a barge towed from pier to pier. After hoisting and attachment at the top of one tower, each rope was similarly hoisted and connected at the top of the other tower. Ropes were then individually adjusted in each span to proper sag.

The footbridge decking is constructed of chain-link wire fencing stretched over 6-in. × 8-in. cross timbers spaced about 10 ft center to center. These in turn are bolted to the under side of the footbridge ropes. Wood posts attached to the ends of each cross member carry wire-rope handrails and the various electrical cables for lights, signals, power control, etc. Cross bridges are

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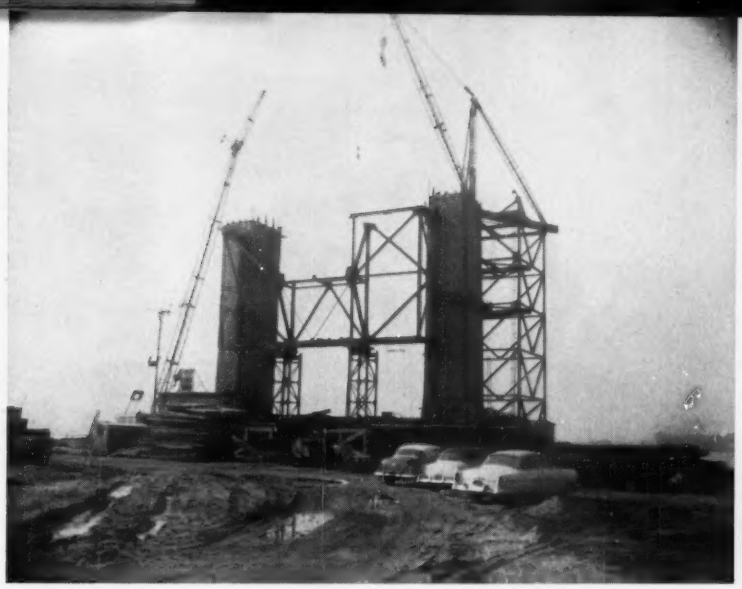
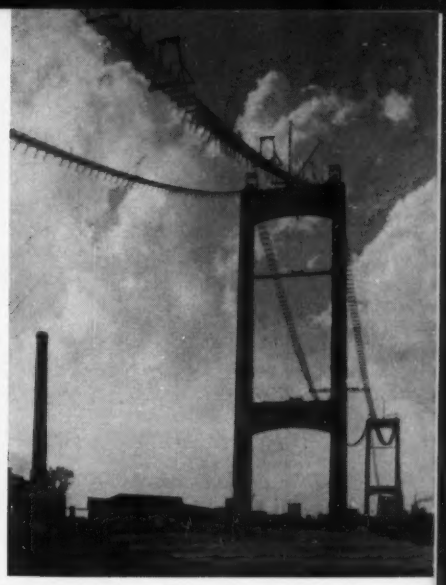


First three tiers of Gloucester towers have been erected by floating derrick. Derrick now assembles creeper traveler, which will erect remaining seven tower tiers.



Walkways are up on Walt Whitman Bridge, in preparation for cable spinning.

located at the center and quarter points of the main span.

To stiffen each footbridge against undulating motions, pairs of arched ropes are connected with vertical ties to the outside footbridge ropes. The permanent hand ropes are being used for this purpose. Over each saddle, and spaced at approximately 200-ft intervals along the footbridges, steel and timber bents support the two parts of endless hauling ropes. At each anchorage these ropes pass around reversible-drive sheaves actuated by Selsyn motor-controlled diesel engines.

Electrically operated clutches permit the hauling ropes to be instantly stopped from various points throughout the lengths of the footbridges. As the cable spinning alternates from cable to cable, the hauling ropes are interchanged on the drive sheaves. Dual spinning wheels are connected to each part of the hauling ropes so that normally four loops, or eight wires, are laid from anchorage to anchorage with each trip of the wheels.

The wire reels are mounted on racks at ground level adjacent to the rear face of the anchorages. On leaving the reels, the wires pass over the top of a compensating sheave tower with double loops inside, in which weighted floating sheaves fluctuate up and down depending on the relative speeds of the reels and the spinning wheels. As the floating sheaves rise, added weight increases the tension in the wire, thus increasing the speed of the reels. In their lower positions, the sheaves actuate brake bands on the reels, in turn slowing them down. However, this mechanism is not entirely automatic, manual aid being required to actually start and stop the reels.

The wires are individually and successively adjusted to proper sag in each span by sliding them through the saddles or around the strand shoes, progressing in the direction of travel of the spinning wheels for the standing, or "dead" wires, and in the reverse direction for the wires which had been the moving, or "live" wires. Thus all excess wire lengths are shifted ahead into the succeeding loops. As each wire is adjusted, it is temporarily clamped at the towers and at each anchorage to prevent it from slipping and destroying the adjustment.

As a further aid in this regard, the tower saddles were set at the balanced tension positions, approximately 2 ft shoreward of their normal positions. As the suspended loads are added to the cables, the saddles will be progressively shifted to their normal positions, at which time holes will be drilled and the saddles permanently bolted to the towers.

The sag adjustments are regulated by men stationed at the mid spans, who signal to others located at the anchorages and tower tops. Initially the sags were established by guide wires set with the aid of instruments, making proper corrections for temperature and the lean of the towers. The wires of the remaining strands are adjusted to arbitrary reduced sags, such as will clear the completed strands below. As for the guide wires, the initial strands of each cable were set to their proper sags with the aid of instruments sighting on inverted target rods lowered through the footbridges at mid spans, making proper corrections for temperature and tower lean. The remaining strands are adjusted to barely clear the strands immediately below. Observations to determine the movement required to accomplish this are made in the early morning, or at a time when all wires are at a uniform temperature.

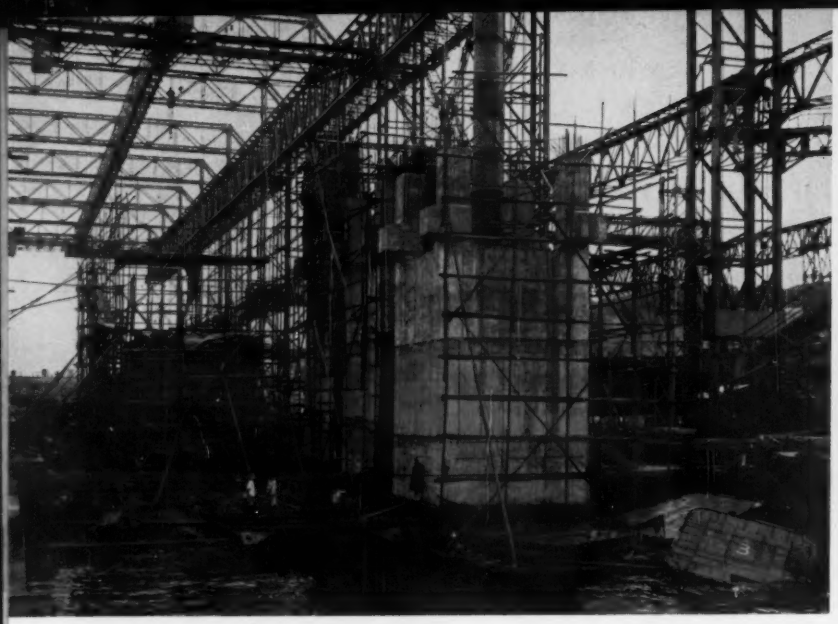
For the main span, the adjustments are made by slipping the strands riverward through one or both of the tower saddles. The corresponding adjustments in the side spans are made by varying the overall length of the eyebar chains. This is done by releasing the stress in the upper-tier bars with a two-part wire-rope tackle containing a hydraulic pulling jack in one part. Shim plates are then removed from between machined blocks (bearing against the pin) and the upper ends of slotted holes in second-tier eyebars.

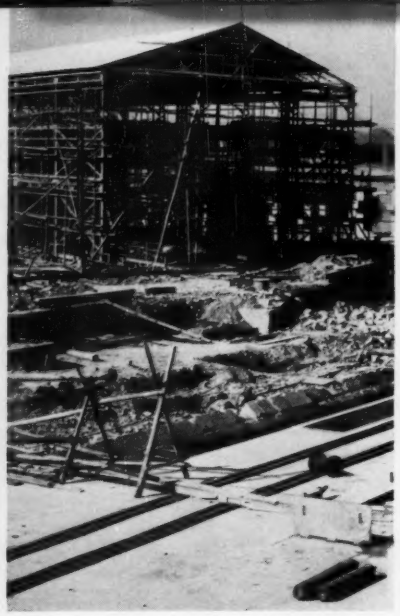
Cable spinning began on November 14, 1955, and on December 22, nine strands for each cable had been adjusted and four additional strands had been spun for the north cable. Normally work is proceeding on the basis of a double eight-hour shift.

When all 37 strands in each cable have been spun, they will be compacted to their circular cross-sections; the cable bands will be applied, and the suspenders hung. Erection of the suspended steelwork can then proceed.

After this is substantially in place, the cables will be machine wrapped between bands with galvanized wire terminating in recesses machined in the ends of each band. These recesses and the joints in the bands will then be calked with lead wool, permitting little or no moisture to penetrate into the cables to corrode the wires.

The contract for the suspended steelwork is held by the Bethlehem Steel Co., whose bid was $7,666,263.90. Preparations for erecting this steel are now under way at each tower.





Caissons and rigid frames combined

RALPH E. RUBINS, M. ASCE

Vice President, Pacific Consultants, Inc.

Construction of a repair pier called the Sherman Seawall Finger Pier at the U.S. Fleet Activities in Yokosuka, Japan, has recently been completed. It is believed that the combination of pneumatic caissons and rigid-frame reinforced-concrete structure used for this pier represents an unprecedented design which has economically met several unusual and severe requirements. This pier, about 300 ft long and 70 ft wide, was constructed for the repair of U.S. Naval vessels in the Far East. See Fig. 1.

First among the unusual conditions governing the design of this structure was its location in Yokosuka Harbor, an indentation of Tokyo Bay. Although this body of water is not subject to heavy seas, it is only reasonably protected from the full force of typhoons which visit the area at intervals of several years. Since it is a repair pier, any ship moored there might be inoperable because of work under way on its main power plant. Therefore the pier structure must be able to resist the wind load caused by exposure of the ship hull to the full force of a typhoon. Further, a large combat aircraft carrier might be under repair on one side of the pier while another large ship was moored to the other side. This condition presents large lateral forces which control the design for pier overturn.

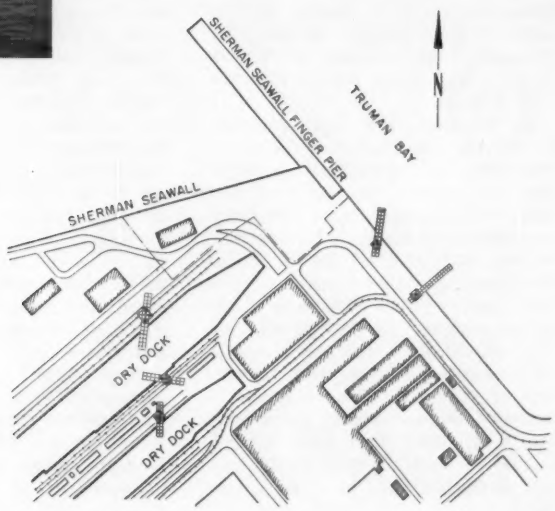
Another factor which is controlling under certain circumstances is the resistance to earthquake shears which have occurred in the Tokyo-Yokohama area. Since this is a repair pier, it must support a traveling crane of very large capacity and reach. These requirements, combined with the wind load and the deck live load of 500 psf, result in rigorous criteria for the stability and strength of the structure.

One other design condition should be mentioned, not because it is in itself a structural limitation, but because it had a considerable effect on the shape of the structure. This was the need for an extremely large capacity for utilities. For instance, low voltage demands for both d-c and a-c required such large conductors that they were designed as solid copper bars installed in trenches recessed into the deck. The width and depth of the trenches needed

Bottom sections of concrete caissons were fabricated in slipways (far left) to exact depth indicated by borings. Note float collars at corners. Rigid frame atop caissons had uniform dimensions throughout structure. In photo at left, deck beams are in place on inshore end of pier.

FIG. 1. Repair pier for U.S. Navy in Yokosuka, Japan, called Sherman Seawall Finger Pier, extends 300 ft into harbor. Structure is 70 ft wide and built to withstand lateral thrust of largest naval vessels with typhoon winds against their hulls.

YOKOSUKA HARBOR



in unique pier

Engineer, Erik Floor & Associates, Inc., Chicago, Ill.

for electrical power as well as for steam, fresh water, salt water, and compressed air brought the total overall depth of the deck slab to about 4½ ft.

Unusual foundation conditions

Then too, the local conditions governing foundations are in some ways unusual and had a considerable effect on the choice of the final structure. The area around the Yokosuka base, and generally throughout the Miura peninsula on which this base is located, is underlain to a considerable depth with fairly soft shale rock, with a tilt up to 30 deg. This material where exposed shows very little deterioration due to weather and can be easily excavated without timbering as is evidenced by the many miles of unsupported tunnel that have been built by the Japanese. All available information indicates that this rock is reasonably uniform to a considerable depth. In the immediate vicinity of Sherman Pier, borings had indicated that there was little or no overburden and that the depth to sound rock was reasonably uniform for a distance of about 300 ft outward from the shore line. Beyond that point, there is a depressed section some 200 ft wide in which the rock was at too low an elevation for economical construction.

Apart from the special climatic and foundation conditions that have been mentioned, other conditions peculiar to work in Japan had to be studied. These included the availability of construction materials and equipment, and a closely related problem, the specific skills of the local contractors and mechanics. One of the most marked differences in this respect from conditions in the United States is the lack of experience with certain types of heavy construction equipment. In Japanese construction, steel piling and jet cutting equipment have been almost entirely overlooked, but the pneumatic caisson method has been highly developed.

Piling ruled out

An investigation of the possibility of using heavy-section H-piling revealed that there was no equipment, floating or otherwise, available in Japan capable of driving such piling in the foundation material to the depth required. If such equipment were to be imported, the cost of construction would go up considerably because of the lack of experience and consequent contingencies added to contractors' bids. At present no steel company in Japan is rolling heavy H-piling sections, although this shortage undoubtedly could be overcome by special rolling or by built-up welded sections. Then also, to secure an economic frame for the design load, it would be necessary to build up cross framework under water by using underwater welding, a method not practiced in Japan at the present time.

It appeared possible to set reinforced concrete piling in holes cut in the rock with hydraulic jets. But again it would be necessary to import the equipment and to pay a high penalty in cost and time for introducing a new technique into the country. It should be noted that the problem of under-water welding of bracing arises again in this case.

One art that has been developed in Japan to a high degree is the construc-

tion of dock walls, gravity walls, and piers using a cut-stone facing and fill. The Japanese are highly skilled in work of this type and can produce an excellent as well as an economic structure. However, the lateral loads to be resisted by the pier more or less ruled out this method of construction.

A large part of the industrial and coastal area in the Tokyo-Yokohama vicinity is heavily overlain with silt and subject to high ground water. For some 30 years the Japanese have solved this problem by the use of pneumatic caissons with the result that suitable equipment and an adequate number of skilled personnel are available for this type of construction. The hours of labor under pressure and the wages of sand hogs make the use of the pneumatic caisson method much more economical in Japan than it is in the United States.

In summary, the basic problems involved in the solution of the design were first, the extremely large lateral load, and second, the equipment and skills available in Japan. The latter practically ruled out either concrete or steel piles, thus leaving for serious consideration only some type of masonry with backfill or an adaptation of the caisson method. In the final selection, the critical factor was the extremely large lateral wind load applied to the top of the pier. This eliminated a masonry structure because an excessive pier width would have been required.

The principal objection to the caisson method is that, in so far as the writer knows, lateral load has always been resisted by the dead weight of the caisson and fill in the caisson box section only. In the present case, the lateral load was so large that a conventional design—with solid walls and rock fill—would require one caisson of almost the full pier width of 70 ft to provide the needed support—an extremely expensive arrangement because of the large size of the caisson and the difficulty of sinking it without tilting.

Investigations were then made of the possibility of designing the structure as a rigid frame using two box-type caissons and the deck members of the frame so that the entire width from the outside of each pair of transverse caissons could be used as a base against overturning. In the course of further study, two facts became apparent. First, the slab depth required to accommodate utilities called for an unusually stiff deck structure but, in spite of this, the moment of inertia was small in comparison to the moments of inertia of the box-type caissons and it was not economical to increase the transverse stiffness of the deck. Second, the resistance to overturning of the rigid frame was such that the additional weight of the concrete caisson walls and interior fill was unnecessary.

Final studies developed a novel solution which, to the best of our knowledge, has not been previously applied to caisson construction in pier work. Since the caisson walls and the interior fill were not necessary for stability, the structure above the caisson working chamber was replaced by four columns stiffened by horizontal tie-beams at the center which, combined with the deck, form a rigid frame with reasonable relationships between the moments of inertia of the component members. See Fig. 2.

No special problems were involved in the structural design of this peculiar frame. Most of the caissons had to have a column length, from the top of the wall above the working chamber to the under side of the transverse deck beams, of 30 ft. This height of column was used in the frame design for all caissons to keep the cross section and reinforcement of all columns and deck beams the same. Some of the caissons required depths as much as 18 ft greater than this to avoid any change in the column design and to increase the buoyancy. In order that the floater for handling these few caissons would not become excessively large, the entire extra depth required was made in the form of a conventional box-type caisson to give substantial fixity at the bottom of the columns.

As has been mentioned, foundation conditions in the Yokosuka area were so well known that there was little uncertainty regarding the depth of penetration required to secure a suitable foundation. An extensive series of borings made before the start of design showed that approximately a 3-ft penetration into the shale would be suitable to provide adequate bearing. Bottom caisson sections were constructed in a slipway to the exact length indicated by the borings and then floated to the site. It was recognized that an additional depth of excavation might be required to overcome caisson tilting, so the columns were designed with sufficient strength without overstress to permit an additional 5-ft section to be built on top if required. In only one of the caissons did it prove necessary to add this section, however.

This combination of pneumatic caissons and rigid-frame superstructure appears to offer economy for pier construction, especially where the lateral load is large.

This project was built under a contract with the Japanese firm of Zenitaka-Gumi. The engineering design was carried out by the Tokyo Branch Office of Pacific Consultants, Inc., and the structural design by Erik Floor & Associates, Inc., of Chicago, Ill. The design contract was under the direction of the Officers-in-Charge of Construction, U.S. Fleet Activities, Yokosuka, Japan, originally under Commander W. J. Thompson, CEC, USN, and later under Capt. J. E. Rehler, CEC, USN.

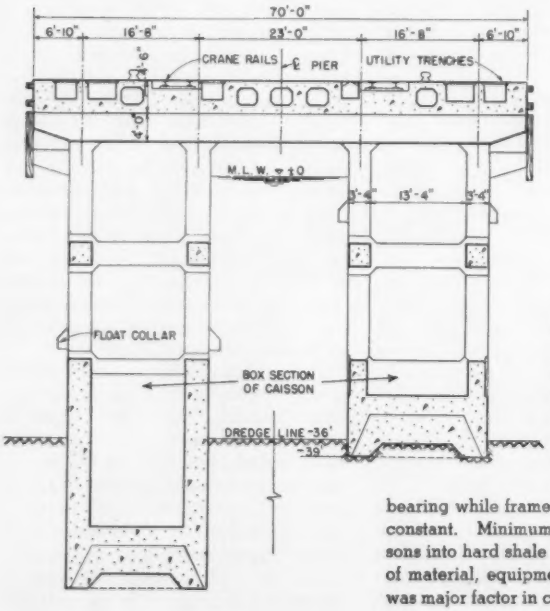


FIG. 2. Typical transverse section through pier shows imaginative combination of pneumatic caissons and rigid frame. Caisson depth varied according to required bearing while frame dimensions remained constant. Minimum penetration of caissons into hard shale was 3 ft. Availability of material, equipment, and skilled trades was major factor in choice of design.

Volume intercepted between two right circular cylinders

B. SAELMAN, Consulting Engineer, North Hollywood, Calif.

The problem of determining the volume intercepted between two right circular cylinders whose axes intersect and are perpendicular is frequently encountered in civil engineering. For example, suppose it is necessary to determine the amount of concrete required to fill a cylindrical reservoir around a street manhole which intersects it. An approximation to the volume is usually made by drafting methods. When the radii of the two cylinders are equal, the intercepted volume is,

$$V = \frac{16}{3}\, a^3$$

where V = volume, in cubic inches
a = radius, in inches

If the radii are unequal, the volume cannot be solved by elementary functions; however, the volume integral can be evaluated, with reference to Fig. 1, using the rectangular coordinate system, in terms of complete elliptic integrals of the first and second kinds. We have:

$$\frac{1}{8}\, V = \int_0^a \int_0^{\sqrt{a^2 - y^2}} \sqrt{A^2 - y^2}\, dz\, dy$$

$$= \int_0^a \sqrt{(a^2 - y^2)\,(A^2 - y^2)}\, dy$$

$$= I \quad . \quad . \quad . \quad . \quad . \quad (1)$$

An integration by parts yields,

$$I = (A^2 + a^2) \int_0^a \times$$

$$\frac{y^2\, dy}{\sqrt{(a^2 - y^2)\,(A^2 - y^2)}} -$$

$$2 \int_0^a \frac{y^4\, dy}{\sqrt{(a^2 - y^2)\,(A^2 - y^2)}} \quad . \quad . \quad (2)$$

Multiplying the numerator and denominator in Eq. 1 by the radical and expanding,

$$I = a^2 A^2 \int_0^a \frac{dy}{\sqrt{(a^2 - y^2)\,(A^2 - y^2)}} -$$

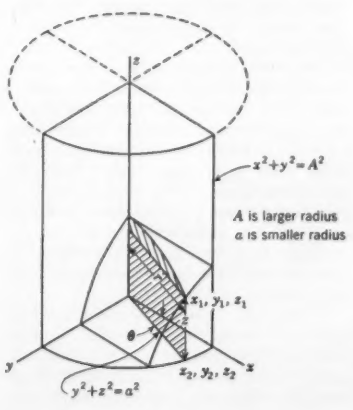
$$(A^2 + a^2) \int_0^a \frac{y^2\, dy}{\sqrt{(a^2 - y^2)\,(A^2 - y^2)}} +$$

$$\int_0^a \frac{y^4\, dy}{\sqrt{(a^2 - y^2)\,(A^2 - y^2)}} \quad . \quad . \quad (3)$$

Multiplying Eq. 3 by 2 and adding it to Eq. 2, we have,

$$3I = 2a^2 A^2 \int_0^a \frac{dy}{\sqrt{(a^2 - y^2)\,(A^2 - y^2)}} -$$

FIG. 1. Intersection of two right circular cylinders, where axes of cylinders intersect and are perpendicular.



$$(A^2 + a^2) \int_0^a \frac{y^2\, dy}{\sqrt{(a^2 - y^2)\,(A^2 - y^2)}}$$

$$. \quad . \quad . \quad (4)$$

If we now set $y = a \sin\theta$ and $a = kA$, we obtain,

$$3I = 2k^2 A^3 \int_0^{\frac{\pi}{2}} \frac{d\theta}{\sqrt{1 - k^2 \sin^2\theta}} -$$

$$k^2 A^3\,(1 + k^2) \int_0^{\frac{\pi}{2}} \frac{\sin^2\theta\, d\theta}{\sqrt{1 - k^2 \sin^2\theta}}$$

$$. \quad . \quad . \quad (5)$$

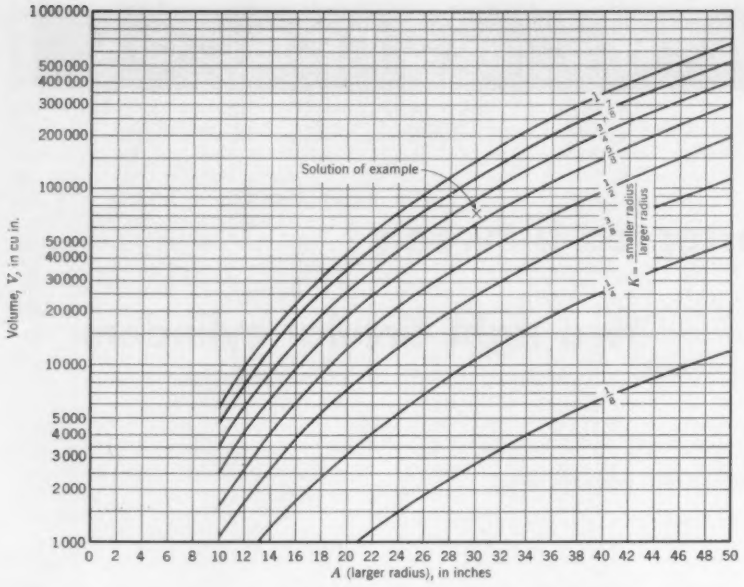
If, in the second integral of Eq. 5, we make the replacement, $\sin^2\theta = \frac{1 - (1 - k^2 \sin^2\theta)}{k^2}$, and multiply the result by 8/3 we have.

$$V = \frac{8}{3}\, A^3\,(k^2 - 1) \times$$

$$\int_0^{\frac{\pi}{2}} \frac{d\theta}{\sqrt{1 - k^2 \sin^2\theta}} + \frac{8}{3}\,(1 + k^2) \times$$

$$A^3 \int_0^{\frac{\pi}{2}} \sqrt{1 - k^2 \sin^2\theta}\, d\theta \quad . \quad . \quad (6)$$

It is seen that the expression for volume given by Eq. 6 involves complete elliptic integrals of the first and second kinds, respectively. When $a = A$, the first term of Eq. 6 is indeterminate but reduces to zero in the limit, and we have $V = \frac{16}{3}\, a^3$. This is usually derived in texts directly by elementary integration.



The volume given by Eq. 6 is plotted in Fig. 2.

Example shows use of Fig. 2

Given: Two right circular cylinders of radii 20 and 30, respectively, whose axes are perpendicular and intersect.

To determine: the volume intercepted between the two cylinders. We have,

$$a = 20 \text{ and } A = 30$$

$$k = \frac{20}{30} = \frac{2}{3}$$

Entering Fig. 2 with $A = 30$ and $k = 2/3$, we find $V = 71{,}000$ in.^{3}

FIG. 2. Volume intercepted between cylinders shown in Fig. 1, plotted from Eq. 6.

THE READERS WRITE

Advocates broader training for engineers

TO THE EDITOR: As Professor Wilbur implies in his article, "The Paradox of Professionalism in Engineering Education," in the November issue, the scope of the engineering profession is a matter of great importance. Plainly the engineer's professional status is dependent upon his full training and his subsequent acceptance of the responsibilities that go with his status.

There seems to be a trend (at least in government circles) for non-technical "administrators" to put all technical personnel—be they engineers, scientists, bricklayers, plumbers, or what not—in the same pot, all labeled "technicians." Thereafter when such an administrator wants a job done that requires technical training, he reaches in and pulls out what he thinks is the appropriate morsel. This points up the need for an accepted standard of professional qualification.

The question is whether present professional training goes far enough beyond purely technical instruction. The principal defect of engineering education is the same as that of practically all other branches of education in the United States, that is, it is limited too much to immediate ends. The average individual seems to be very competent in the fields of knowledge by which he earns his livelihood but beyond those fields he is wholly lost. Engineers are no exception. Too often in national life attempts are made to solve profound problems by superficial means, or by methods that are merely expedient, instead of seeking solutions on the basis of fundamental principles.

Professional training should manifestly take into consideration the fact that an individual is a member of society before he can be a member of a profession and therefore has obligations more basic than those of his profession. Some elementary understanding, at least, should be acquired in related fields of knowledge, such as geography, history, politics, and sciences outside the chosen profession, as well as in literature and the fine arts. Courses in ethics and logic should also be included; these should not be limited to engineering students. The course in ethics would provide a basis for evaluating one's responsibilities and one's rights in both professional and non-professional activities. The course in logic should develop the student's ability to appraise the truth; it should enable him to avoid the pitfalls of hokum that beset him on all sides.

This additional training may require more time than the four years now generally allotted to engineering education. But if more time is necessary, it should be taken.

EDGAR E. FOSTER, M. ASCE
Consulting Engineer
Wheatridge, Colo.

Radioactive wastes—a critical problem

TO THE EDITOR: Regarding Colonel Jackson's article in the December issue, I should like to make the following statement although I do not presume to be a nuclear engineer.

In this article, "What Is the Future for Nuclear Power Plants?" some thought-provoking questions and data are presented. For many years now we have been cautioned about the rapid depletion of our sources of fossil fuels. It is therefore easily understood that we immediately look to this new source of power in atomic fuel. However, before we run out and buy a handy, automatic, pocket-sized, nuclear reactor, we should consider some of the other aspects of the use of nuclear fuels that were not presented in the article. These aspects will definitely affect the economical justification of the use of nuclear fuels and will also impose a potential hazard to public health and safety.

One of the primary factors that should be considered is the disposal of the radioactive fission products. Technological advances in the production of atomic power have far surpassed the development of adequate disposal methods for the radioactive wastes. Some of these waste fission products have half-lives of thousands of years. The present method of disposal is largely by burial. This can be considered only a temporary measure in view of the long life of some of the constituents of the waste.

The stream pollution program for organic and industrial wastes has been slowly developing in this country to a point where it is now under effective regulatory control. However, the state health agencies are not yet ready to cope with the possibility of stream and air pollution with radioactive wastes. It will be some time yet before sufficient numbers of trained personnel are recruited for the primary task of determining natural background levels in the streams and in the air. This information must first be obtained to enable us to detect and measure radioactive pollution.

As yet we can only estimate the tolerance level of the human body with regard to the different types of radiation. We can only speculate about the mutations produced as a result of an increase in the level of background activity.

Finally, there is always a possibility, although perhaps a slight one, that through human error or mechanical malfunction, a build-up may be produced by the reactor, or a spill of radioactive material may occur. Such things are not improbable since they have happened.

It is important, in spite of the need for new sources of power, that both the bright and the dark side of this picture be developed equally for proper perspective. This is especially important where the safety and well-being of humanity may be involved. There is a critical need for high-level research, comparable to the intensive research that has taken place in the field of power production, to develop methods for neutralizing or disposing of radioactive waste products.

MARVIN SKODJE
Ames, Iowa — *Sanitary Engineer*

Spliced steel columns with unequal moments of inertia

TO THE EDITOR: After reading the interesting article, "Where Should a Steel Column Be Spliced?" by Prof. W. A. Andrews (June 1955, p. 62), I became curious about the effect, on the critical elastic buckling load, of increasing the moment of inertia of one of the spliced members.

Extending Professor Andrews' work to the more general case of spliced columns having unequal moments of inertia, and reversing k so that $kL = a$ (Fig. 1), the resulting transcendental equation is,

$$\tan (1 - k)pL + \frac{p}{q} \tan kqL = pL. \quad .(1)$$

$$\text{where, } p = \sqrt{\frac{P_{cr}}{EI_b}} \text{ and } q = \sqrt{\frac{P_{cr}}{EI_a}}$$

For the special case of equal moments of inertia, $p = q$, Eq. 1 is reduced to:

$$\tan (1 - k)pL + \tan k\,pL = pL. \quad .(2)$$

This equation is equivalent to Professor Andrews' Eq. 4.

Figure 1 illustrates the idealized case used in deriving Eq. 1. Figure 2 shows the graph of C values versus k, the splice location, expressed as a fraction of the story height. Values of C for various values of k are given in Table I.

As could be expected, the increase in critical load was more significant for the upper maximum than for the lower maximum, and the location of these maxima rose as the moment of inertia of the lower member was increased. This shift of maximum load position brings about a somewhat surprising result. With the hinge located 0.7 to 0.75 of the story height, the critical load is insignificantly altered by increasing the longer member's stiffness. This is in spite of the fact that the lower member is much longer, and therefore, seemingly more governing.

There is virtually no increase in critical load as a result of increasing the lower member's stiffness, I_a, if the splice is in the lower fifth of the story height.

BRADFORD C. HOUSER
Engineer, Sandberg-Serrell Corp.
Pasadena, Calif.

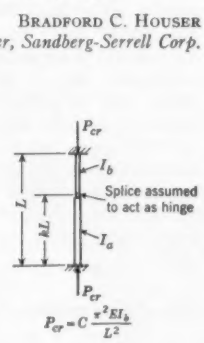


FIG. 1. Idealized case of critical load on spliced column used in deriving Eq. 1—elastic buckling with zero eccentricity

TABLE I. Values of C for various k values

Splice Location, k	Values of C: $I_a = I_b$	$I_a = 1.5I_b$	$I_a = 2I_b$	$I_a = 4I_b$
1.00	2.04	3.07	4.09	8.18
0.90	2.53	3.78	5.04	10.02
0.85	2.82	4.20	5.59	9.18
0.80	3.11	4.38	4.89	5.27
0.75	2.89	3.09	3.19	3.43
0.70	2.06	2.14	2.22	2.55
0.60	1.21	1.34	1.50	2.05
0.50	1.00	1.25	1.49	2.48
0.40	1.21	1.67	2.12	3.79
0.35	1.52	2.14	2.76	4.36
0.30	2.06	2.90	3.55	4.07
0.25	2.89	3.43	3.53	3.59
0.20	3.11	3.15	3.17	3.18
0.10	2.53	2.53	2.53	2.53
0.00	2.04	2.04	2.04	2.04

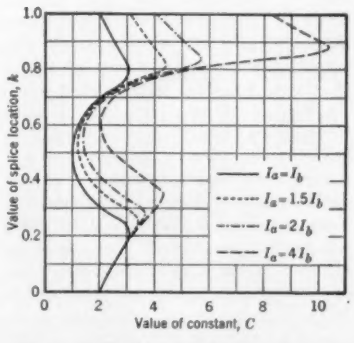


FIG. 2. Graph of C values versus k, splice location, expressed as a fraction of story height.

SOCIETY NEWS

Public Works Conference Studies Policies and Problems in Government Agencies

Leaders in the public works field, federal, state and municipal, met at the Octagon in Washington, January 16 and 17, under the auspices of the ASCE, the American Institute of Architects, and the Chamber of Commerce of the United States, to discuss the role of public works in the construction field for the coming year. The purpose of the conference was to acquaint the professional societies with the programs envisioned in this important field of governmental activity. As was pointed out by Maj. Gen. John J. Bragdon, Special Assistant to the President, last year $12 billion dollars of public works construction was put in place. Speaking before the assembly at the Tuesday luncheon, General Bragdon noted that not only is the volume of public works construction significant to the health of our economy, but that it directly affects our daily lives and that decisions and plans made today affect the generations to come.

Role of Government in Planning

In outlining the Federal Government's role in planning public works, General Bragdon emphasized that it is not the intent of the Federal Government's program, ". . . in any way to replace like activities which normally are a function of states, counties, cities and towns." He further stated that, "the Federal Government should exert leadership in public works planning to point the way toward eliminating the backlog of needed public works." This need he stated is being estimated at $300 billion, of which two-thirds is non-federal. Because of the nature of public works construction, General Bragdon declared that "needs should be ascertained on a long-range basis, . . . as far ahead as it is practical to foresee." He applauded the Public Works Conference as an excellent example of the needed collaboration between government officials and members of the professions.

James W. Follin, M. ASCE, Commissioner of the Urban Renewal Administration, Housing and Home Finance Agency, spoke of the public works aspects of the urban renewal program, pointing out the terrific impact the program has on the construction industry. In noting that the actual government subsidy represents only a small part of the construction generated in a rehabilitation program, the Commissioner cited the following figures: "Government aid in demolishing the estimated five million non-salvable dwelling units and improving the neighborhoods where over five million substandard but salvable units exist, is estimated at over $15 billion dollars. Total construction expenditures in such a mammoth program would amount to more than $75 billion." Such a program, Mr. Follin went on, "if concentrated in a period of declining business could be extraordinarily useful. The apparently high multiplier, one public dollar generating four construction dollars, far exceeds experience on any previous federal-aid program."

From an economic point of view, the speakers presented a very encouraging picture for the next several years. Estimates from the Department of Health, Education and Welfare indicated a need for 210,000 new classrooms in the next five years to handle increased enrollment alone. Provision of federal grants, matched by the states, is designed to achieve the goal of 470,000 classrooms over the next five years.

Good Outlook for Materials

Of vital significance to any project planning of course is the availability of materials. Speaking for the steel producers, N. P. Hayes, M. ASCE, first vice-president of the American Institute of Steel Construction, noted that the tremendous jump in construction volume in 1955 placed a heavy load on steel fabricators. The industry increased production about 15 percent in the past year. However, new orders jumped 50 percent in the same period. At present, there is a backlog of about eight months' work on the fabricators' books. Some of this is for 1957 delivery, and smaller jobs involving less critical mill products can expect reasonably quick delivery. A bright spot in the steel picture is the anticipated 12 percent increase in fabricator shipments, and the mills' promises of greatly increased rolling of shapes.

Speaking of materials other than steel and cement, Walter W. Schneider, of the Department of Commerce, stated that the problems of material supply that cropped up in 1955 will progressively diminish through 1956. The main difficulty in the coming year will be one of place utility—that is, having the right material at the right place at the right time. A complicating factor is the growing shortage of freight cars. A possible sore spot may be steel boilers. With steel still tight boiler stocks will not be built up. Likewise a nickel shortage may affect the supply of heating controls.

Architect-Engineer Contracts Studied

Particularly valuable to the development of a sound national public works program was that portion of the conference devoted to "Architect-Engineer contracts and related problems in government agencies." During this session, representatives of the Public Buildings Service, the Atomic Energy Commission, the Department of Defense, the Public Health Service, and the Department of Interior outlined their programs and policies. In speaking for the AEC, William K. Maher, deputy director, Division of Construction and Supply, outlined procedures for the procurement of Architect-Engineer services as follows:

"The objective of this procedure is to obtain the services of the best-qualified firm available. In attaining this objective, it is the policy of AEC to consider within practical limits all firms qualified to perform the work. The procedure involves analyses of the requirements of the work and development of data on firms considered well qualified to furnish the required services from information supplied from the firms either by proposals, through personal interviews or inspection of the facilities of the firms, or from other sources which can supply pertinent and reliable information. After a thorough evaluation, the available firm best qualified is determined. Fee proposals for architect-engineer services are not solicited as a part of the evaluation procedure in selecting a contractor."

Leonard L. Hunter, supervising architect, Design and Construction Division, Public Buildings Service, pointed out that for 1956 only 4 percent of the total dollar value of work under PBS jurisdiction is performed by PBS staff. He further stated that, "Negotiated lump-sum contracts are used for professional services." In speaking of compensation for professional services, he said the, "PBS has established a curve of fees for projects of average complexity. These fees are modified by a predetermined percentage to arrive at an acceptable fee for the services under consideration."

Hazelet and Larson, Co-chairmen

Particular credit for this well planned and useful conference goes to the Conference Committee, which was headed by Craig P. Hazelet (ASCE) and Roy F. Larson (AIA) as co-chairmen. The other committee members are Edmund R. Purves (AIA); F. Stuart Fitzpatrick (C. of C. of U. S.); W. O. Hiltabidle and Joseph H. Ehlers (ASCE); and Edwin B. Morris, Jr. (AIA). Mr. Ehlers was in charge for ASCE, Mr. Morris, for the AIA, and John A. French for the Chamber of Commerce of the United States.

EJC Names New President

Thomas H. Chilton, technical adviser to the engineering department of E. I. du Pont de Nemours & Co., has been named new president of Engineers Joint Council and is taking office on January 27. A former vice-president of EJC and chairman of its Engineering Manpower Commission, Dr. Chilton is also a past-president of the American Institute of Chemical Engineers.

Pacific Southwest Conference to Feature Long Beach Harbor Tour

Program for Pacific Southwest Conference—to be held at Pasadena, Calif., April 19–21, with Los Angeles Section as host—will feature Long Beach Harbor field trip. Shown here in aerial view, the $144,000,000 development is concentrating much attention on remedial works to rehabilitate sinking land and facilities. In progress and on display for ASCE members making the tour will be such interesting and diversified projects as deep-water wharf construction; tilt-up warehouses; 160-ft clear-span transit sheds; $20,000,000 worth of bridge construction; thousands of feet of track work; and millions of tons of earth fill, to mention a few. In this aerial view Pier A, longest in the world, predominates. Details of this and other features of the program will appear in the March issue.

More Information on Division Journals

January 1956 marks the first mailing of Proceedings in a new format. Basically, the only difference from past practice is that individual Proceedings Papers are now assembled and bound by Divisions, under a distinctive cover. The Divisions will publish their Journals in differing months, some bimonthly, some quarterly, and some irregularly. The Journals will be entitled, for example, "Journal of the Highway Division." The historic Proceedings volume number is maintained and projected over the new series. Each paper will also have a serial number which follows the sequence established in February 1950. Payment of dues entitles each member to request that his name be placed on the mailing list to receive any two Division Journals. It also entitles members to receive every fiscal year, beginning October 1, as many as 100 individual papers. These are mailed to members following receipt of a marked coupon, published each month in CIVIL ENGINEERING, with the Proceedings Abstracts.

The Journals are numbered consecutively, with a two-letter and numeral designation—for example, "SM3." If the number of a paper is known, its Journal location can be found by reference to the inside back cover. For example, Paper No. 870, on the inside back cover of all the January 1956 Journals, appears with the notation 870 (EMI), indicating that it is to be found in issue No. 1 of the Journal of the Engineering Mechanics Division.

Technical writers will find it convenient to phrase references to Proceedings Papers (for example) as follows:

"*Proceedings*, ASCE, Vol. 82, EMI, January 1956, Table 63, p. 352"

The last paper published each year is an annual index. It will be issued as part of the Journal of the Board of Direction and mailed automatically to national officers of the Society. Other members may receive their free copy, if desired, by marking and mailing the coupon in CIVIL ENGINEERING.

Edward S. Kirkpatrick Joins Society Staff

Edward Stuart Kirkpatrick, J. M. ASCE, former district public health engineer for St. Louis County, Missouri, has joined the ASCE headquarters staff in New York as assistant to the Secretary. A native of Richmond, Va., and holder of two degrees from Georgia Institute of Technology, Mr. Kirkpatrick was sales engineer for Infilco, Inc., at Tucson, Ariz., and in the Atlanta, Ga., area before taking up his St. Louis post in November 1954. From November 1943 to July 1945 he was in the Army Air Corps.

In his work for ASCE Mr. Kirkpatrick will facilitate the coordination of member activities, with special attention to the Local Sections. He will make his home in suburban Tuckahoe, N.Y.

Edward S. Kirkpatrick, J. M. ASCE, assumes new duties as assistant to the Secretary of ASCE.

"Seven Wonders" Program Arouses Nationwide Interest

In the selection and widespread announcement of the Seven Modern Civil Engineering Wonders of the United States, ASCE scored two accomplishments with the general public. It stimulated anew a realization and appreciation of the mighty achievements in the field that have been vital in the nation's history, and it brought home to many what kind of people civil engineers are and what kind of work they do.

Perhaps few articles published in CIVIL ENGINEERING have aroused such interest and so many expressions of approval as that in the November 1955 issue, in which James Kip Finch, chairman of the Special Committee on the Seven Wonders Selection, reported on the choices and presented an impressive review of each of the seven. The many letters received and the thousands of reprints ordered by schools of engineering, the Bureau of Reclamation, and others attest to the popularity and value of Dean Finch's presentation and the value of its content. For a limited time the article is being held in type so that orders for reprints, if received soon, may be filled. In lots of a hundred or more, copies for educational purposes, are priced at five cents each, and copies for commercial or business purposes at ten cents each.

Immeasurable public interest in the Seven Wonders and in civil engineering resulted from publication in the November 1955 *Reader's Digest*, of an eight-page article on the selections written by Ira Wolfert. This magazine, which cooperated extensively, released two special films—one two minutes and the other five minutes long. These were shown on a majority of the 200 TV stations to which they were submitted. The magazine also arranged for other broadcasts on TV and radio. Several copies of the five-minute film, showing a few of the Wonders, have been given to the Society by *Reader's Digest*. These are available on loan to Sections and schools of engineering. They are 16-mm. black and white, silent. While these films would not by any means constitute a full program, they could be used effectively as a program feature.

Also available, on loan, are sets of black and white slides, one for each Wonder. These, like the films, are available on request to the Public Relations Department at national headquarters. Many Sections and schools already have requested and received material on the Seven Wonders. Several schools plan exhibits during the commencement season.

As expected, the Seven Wonders announcement resulted in a flood of newspaper stories, editorials, and comments by columnists, and in substantial attention from radio, too. One broadcaster reported the selections on forty stations. As with the letters from members, there were few expressions of dissent in the press, though many undoubtedly had their own ideas as to which projects should be considered the Seven Wonders.

Time Magazine presented two pages of photos, as did the Saturday magazine of the *New York World Telegram and Sun*. The *Chicago News* ran virtually a full page of photos. The *Minneapolis Sunday Tribune* Picture Magazine devoted three rotogravure pages to the subject. The press also gave substantial other space to the Wonders.

The Bureau of Reclamation has been particularly active in calling attention to the selections. The United States Information Agency obtained photos and data which, it wrote, were "transmitted to our overseas posts." It issued 180 sets to embassies, legations, and other U. S. Government units throughout the world. A representative of the Voice of America obtained material for a contemplated 15-minute broadcast for Germany.

The Empire State Building in New York City conducted an extensive promotional campaign as a result of its choice as one of the Seven Wonders.

Construction Division Survey Studies Project Activities

Results of the Construction Division's Second Industry Survey Report are now available. To determine the project activities of ASCE members and their influence in the construction markets, a group of 900 members were sent questionnaires. Of these almost 300 returned replies. Analysis of the report reveals several interesting facts: (1) There is no field of engineered construction in which ASCE membership does not play a dominant role; (2) 26 major types of projects were mentioned specifically in the study; and (3) civil engineers have a major influence in specification of practically every type of construction material and installed equipment required to complete the above-mentioned types of projects.

Among those groups answering the questionnaire it was found that the average consulting firm employed a little over 33 civil engineers. The average of the contractor firms replying employed 31 civil engineers, as compared to 5 civil engineers per architectural firm replying. Persons interested in the report may obtain a copy from CIVIL ENGINEERING.

ASCE MEMBERSHIP AS OF JANUARY 9, 1956

Members	9,076
Associate Members	11,675
Junior Members	17,534
Affiliates	70
Honorary Members	41
Total	38,396
(January 9, 1955	37,887)

Research Prizes to Be Presented at Dallas

Presentation of the Society's Research Prizes for outstanding accomplishments in that field will be made to three ASCE members at the Membership Luncheon on February 15 during the Dallas Convention. The winners are Dr. Lynn S. Beedle, of Lehigh University; Dr. Eivind Hognestad, manager of the Structural Development Section of the Portland Cement Association, Chicago; and Prof. Philip F. Morgan, of the State University of Iowa.

Dr. Beedle is being honored "for his experimental and theoretical investigations into the fundamental nature of residual stress in structural steel," which it is believed may lead to change or modification of existing specifications with ultimate increase in efficiency and economy in the design of structural members. Dr. Hognestad will be honored for outstanding work in research on structural reinforced concrete, the results of which "have contributed immeasurably to the advancement of understanding in the field of civil engineering." Professor Morgan is cited as one "of the outstanding members of the sanitary engineering profession in his contributions in the field of sewage treatment and wastes disposal" notably in developing a method for the digestion of sewage sludge that has decreased digestion time.

The prize consists of a check for $100 and an appropriate certificate.

Alfred Noble Prize Goes To Electrical Engineer

The Alfred Noble Prize for 1955 has been awarded to R. L. Bright, a young electrical engineer and associate member of the American Institute of Electrical Engineers. It goes to Mr. Bright for his paper, "Junction Transistor Used as Switches," which was published in the March 1955 issue of the AIEE journal, *Communication and Electronics*. An alumnus of Carnegie Institute of Technology, Mr. Bright is an instructor there now. Presentation of the award to him was made during the winter general meeting of the AIEE held in New York.

A joint award of the four Founder Societies and the Western Society of Engineers, the prize was established in 1929 in honor of Alfred Noble, Past-President of ASCE and of the Western Society of Engineers. It consists of a cash award of $400 and a certificate, and is given annually for a meritorious technical paper by a young member of one of the participating societies.

Results of 1955 Readership Survey Reported

To make CIVIL ENGINEERING as widely useful as possible, the editors have been conducting monthly surveys of reader opinion since 1949. Some of the questions to which these readership polls have sought answers are: What is your favorite feature? Which article do you like best? How can advertising be made more helpful to you? How can CIVIL ENGINEERING be made more useful to you?

In response to the questionnaires sent out (some 200 each month selected at random), almost 6,000 engineers have gone out of their way in the past six years to tell us what they like and don't like and to make suggestions for improvement. For these suggestions and the many good ideas for articles that have been volunteered, many thanks!

In answer to the 2,400 questionnaires sent out in 1955, 726 replies have been recorded. The average member reported that he devotes 2 hours and 48 minutes reading time to CIVIL ENGINEERING each month. As in other years, the articles were the favorite feature, "News Briefs" a clear-cut second choice, and "Equipment, Materials and Methods" third choice. A tabulation by month of the most useful articles is included here.

Responding to the question, "Do the advertisers in CIVIL ENGINEERING help keep you up to date on equipment and materials used in your work," 85 percent said that they do. To the query, "In your work do you direct the procurement of equipment and materials," 72 percent of the readers answered that they buy, specify, or are consulted about the purchase of equipment and materials.

1955 Articles Selected as Best in Readership Survey

MONTH	TITLE	AUTHOR
Jan.	Employers, Ethics, and Young Engineers	Clement J. Freund
Feb.	Construction Management Needs the Civil Engineer	Dwight W. Winkelman
March	Changing Engineering Education—Do We Understand It?	W. S. Evans
April	A Monorail System for Los Angeles	George W. Burpee
May	*Unions, Unity or Utopia (a panel discussion)	Hugh Mulholland, Harold A. Halldin, W. J. Keener, Hodge Gaines
	*What's Wrong with Engineering Education	H. L. Danforth
June	Mexico's Palace of Fine Arts Settles 10 Ft—Can It Be Stopped?	J. H. Thornley, C. B. Spencer, P. Albin, Jr.
July	New York Coliseum Designed for Fast Construction	Jacob Feld
Aug.	Competitive Bidding—Impact of Modern Business on Practice of Engineering	Raymond A. Hill
Sept.	Unionization—A Vital Question Awaits an Answer	Baxter W. Napier, Jr.
Oct.	A Construction Engineer Talks About the Tools of the Trade	J. G. Tripp
Nov.	Seven Modern Civil Engineering Wonders in U.S. Named	J. Kip Finch
Dec.	Who Wants a Civil Engineer	D. Lee Narver

* Tied for first place in May

Set-up of Europe–U. S. Engineering Conference (EUSEC)

WILLIAM R. GLIDDEN, Past-President ASCE

EUSEC is an important international engineering organization, and one in which ASCE has been an active leader since its formation in London in 1948. There have been five meetings of EUSEC: the organization meeting in London in the fall of 1948, another in London a year later, the third in The Hague in September 1951, the fourth in Paris in the fall of 1953, and the recent meeting in Copenhagen, Denmark (November issue, page 70).

Under its constitution EUSEC is composed of "one or more of each of the participating countries. These engineering institutes are deemed to represent fully the professional engineers of the country concerned and be free to act in that capacity." The constitution provides that, "If a country is not yet represented in EUSEC, the most prominent engineering institute of that country may be invited to join as a member. The admission of such an institute needs the unanimous approval of the members of the EUSEC."

The countries represented in EUSEC are the United States and Western Europe, including Austria, Belgium,

Denmark, Finland, France, Germany, Holland, Italy, Norway, Sweden, Switzerland, and the United Kingdom. The United States is represented by ASCE, ASME, AIEE, AIME, and AIChE. Representing the United Kingdom are the Institutions of Civil, Mechanical, and Electrical Engineers.

EUSEC was established to develop direct relationships among the participating societies on a basis of mutual understanding, and thus

1. To aid in the advancement of engineering science and practice.
2. To advance the common aims and objectives of the participating societies.
3. To give all proper support to each participating society within its own country (and for this purpose no participating society will initiate any action within the country of another without first informing the participating society of the country and obtaining its cooperation).
4. To act as a focus of the professional engineering opinion of the participating societies.
5. To cooperate, as may be considered desirable, with international organizations and to support and supplement their work.

Until the recent meeting in Copenhagen all meetings of EUSEC were attended by the president and secretary of ASCE, ASME and AIEE, but this year AIEE was not represented. The other participating societies are similarly represented by their officers.

Developed through a carefully compiled agenda, the conferences usually last four or five days and are substantially management conferences. The development of an understanding relationship of mutual profit, afforded by these meetings, is of extreme importance. Another important benefit is in the contacts made, which could be exceedingly useful in times of stress and emergency.

The proceedings are conducted in two official languages, English and French. The interpreters carry on their work in a glass-enclosed booth, and head phones and microphones are furnished for the use of each delegate. Their work at the Copenhagen meeting was so efficient that usually the interpretation was no more than five words behind the original utterance.

Each society assumes its own expense, and the only expense common to all is the relatively small cost of the interpreters and the reproduction of the minutes, resolutions, etc., of each conference. The secretaryship resides in the country most recently serving as conference host.

Engineering Education Conference

As a result of EUSEC activities, an international conference on engineering education has been set up. ECPD has represented the United States and participated in a conference just concluded on engineering education in Zurich.

As we worked through the agenda at the Copenhagen meeting important differences in engineering practice in the various countries were revealed. In discussing the definitions of the terms "Professional Engineer" and "Engineering Technician," it was found that some of the continental countries, particularly France, recognize no shade of difference between the two designations.

A shortage of engineering manpower in all the countries except France was revealed. Secretary Georges Ville, of La Societé des Ingenieurs Civils de France, declared that he had not seen a single reference to a shortage of engineering manpower in that country. This is an interesting situation, because in France the supply of engineers is limited through its system of education. Apparently just enough young men enter engineering practice each year to keep pace with current demands, and the tendency is for these engineers to stay in the profession because of superior recognition and emoluments. In England, it was reported, engineers in private practice are having difficulty recruiting their forces because of the high compensation received by engineers in public service. In Austria the ranks of engineering personnel are being severely depleted by emigration into other countries. The Swiss delegate declared that it was illusory to forecast the future demand for engineers because of uncertain and varying economic conditions.

The subject of professional ethics occupied a prominent part in the discussions. In England, the distribution of brochures detailing an engineer's experience and qualifications, which is customary in this country, is denounced. Competition on a price basis is common practice in France, and on the majority of construction work the engineer acts also as the contractor. Commonly the engineer bids on his own design. There is no doubt that such an arrangement results in the exploitation of original ideas and thus contributes to technical advance. The French delegate spoke on the freedom from regulation underlying all private enterprise in France and deplored the restrictions current in some of the other countries.

Thus the conference revealed considerable variance in engineering practice among different European countries and the United States. It would be futile for EUSEC to try to establish uniform practices, as there are too many obstacles of national prejudice and usage to be overcome. Nevertheless the discussion gave a stimulating picture of practice in the various countries.

Coming Events

Illinois—Weekly luncheon meetings at the Chicago Engineers Club. Details from Section headquarters, 4520 W. North Ave., Chicago.

Los Angeles—Host to the Pacific Southwest Council Conference at the Huntington-Sheraton Hotel, Pasadena, April 19–21. Sterling S. Green is general chairman.

Intermountain—Dinner meetings the third Friday of every month, except June, July, and August. Exact time and place from R. E. Spears at El 9-8372.

Metropolitan—Meeting in the auditorium of the Engineering Societies Building, New York, N.Y., February 15, 7:00 p.m.

Mid-South—Spring meeting at the LaFayette Hotel, Little Rock, with the Little Rock Branch as host, April 26–28. Cocktail party Thursday evening, technical program on Friday, and field trip to the new Little Rock Air Base Saturday morning.

Nashville—Section is one of sponsoring groups for all Engineers' Dinner at Hillwood Country Club, February 21, 6:30 p.m. Featured speaker is Brig. Gen. Herbert D. Vogel, chairman of the board of the TVA.

National Capital—Annual dinner at the Army-Navy Country Club, Arlington, Va., February 7. President Needles and Executive Secretary Wisely will be guests, and Rear Admiral Robert H. Meade, new chief of the Bureau of Yards and Docks, will be principal speaker.

Northeastern—Meeting at the M.I.T. Faculty Club, 50 Memorial Drive, Cambridge, Mass., February 20, 7:30 p.m. Col. Sydney H. Bingham will speak on "Mass Transportation." Social hour at 5:30 p.m., and dinner at 6:30 p.m.

Providence—Host to the third Regional Conference of the New England Council at Brown University, Providence, April 7.

Scheduled ASCE Conventions

DALLAS CONVENTION
Dallas, Tex.
Hotel Baker
February 13–17, 1956

KNOXVILLE CONVENTION
Knoxville, Tenn.
University of Tennessee
June 4–8, 1956

PITTSBURGH CONVENTION
Pittsburgh, Pa.
William Penn Hotel
October 15–19, 1956

NOTES FROM THE LOCAL SECTIONS

(Copy for these columns must be received by the tenth of the month preceding date of publication.)

"Clean water" was the topic of the **Akron Section's** November meeting. A 20-minute film, which gave an idea of the problem of obtaining potable supplies, was followed by a talk on "Ohio's Stream Pollution Elimination Program." F. H. Waring, chief engineer of the Ohio Department of Health, was featured speaker.

Raymond E. Strickland, of Birmingham, is new president of the **Alabama Section.** Elected to serve with him at the Section's annual meeting, held at Montgomery early in December, were Kenneth C. Roberts, Mobile, first vice-president; Warren G. Keith, Tuscaloosa, second vice-president; and R. G. Davis, Birmingham, secretary-treasurer. In a featured talk, Louis M. Smith, president of the Alabama Power Co., predicted that by 1975 progress in controlling radiation hazards will make it possible for atomic power plants to provide 10 percent of the electric power needs of the country. At present, he noted, the most widespread peacetime application of atomic energy is in the use of radioisotopes in industry and agriculture. "Radioisotopes are used in industry to detect defects in materials, to gauge dimensions, to control the flow of liquids in pipelines and to detect leaks," Mr. Smith explained.

In the **Arizona Section** the 1956 slate is Wilbur Heckler, Tucson, president; Leigh Gardner and Clarence Whalin, both of Phoenix and both vice-presidents; and Robert M. Cushing, Tempe, secretary-treasurer (reelected).

Adolph Ackerman, consulting engineer of Madison, Wis., and visiting professor at the University of Illinois, spoke informally at the **Central Illinois Section's** December meeting on the work of the ASCE Task Committee on Engineering Education. The committee is currently concerned with an evaluation of the present system of engineering education and the best utilization of the engineers trained in the system. New Section officers, announced at the meeting, are Ralph B. Peck, president; Junius R. Gardner and Ellis Danner, vice-presidents; and William H. Munse, secretary-treasurer. Outgoing President R. A. Hanson received the thanks of the Section in the form of a certificate.

The **Cleveland Section** is active again in the Vocational Guidance Program sponsored by the Cleveland Technical Societies Council. It will put on a TV program on Sunday, March 29, to be broadcast by local stations. Recently the Council sponsored a three-day series of Career Conferences in the Cleveland high schools with good results. In the featured talk Thomas C. Kavanagh, member of the New York consulting firm Praeger-Kavanagh, spoke on welded bridge design with special reference to recent projects of his firm—the Rio Blanca Bridge in Mexico (longest welded arch bridge in the hemisphere) and the temporary and permanent Barnhart Island bridges.

New **Colorado Section** officers are Francis M. Bell, president; Dewey S. Wright, vice-president; and Emerson S. Ellett, secretary-treasurer. "Engineering Registration Brought Up to Date" was the subject of a highly worthwhile talk given at the January meeting by Frank Prouty, Cleveland consultant and long-time member of the local Board of Examiners.

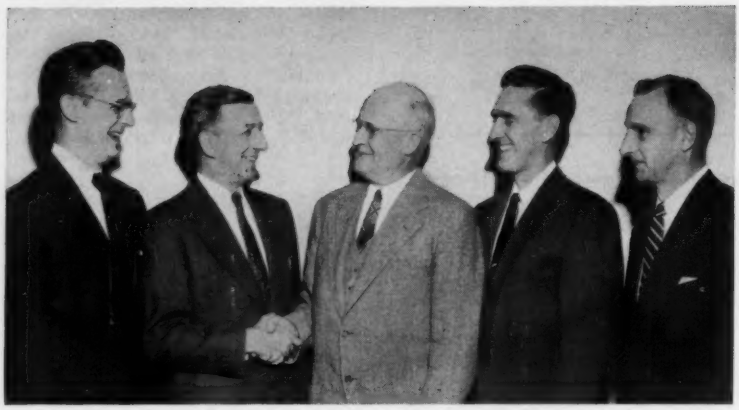
Dana Young, professor of civil engineering at Yale University, was featured speaker at the **Connecticut Section's** December meeting, with a talk on "Vibrations in Structures." ASCE Director F. H. Paulson spoke briefly on the proposed revision of the Code of Ethics.

Though the **Illinois Section** ranks fifth in membership, local committees are stepping up a drive to advance it to third place. Prof. J. O. Osterberg, of the Northwestern University Technological Institute, was guest speaker at the November meeting, with the provocative subject, "Large Settlements from Small Structures and Small Settlements from Large Structures." Professor Osterberg cited a single-story housing project in Gary, Ind., which settled as much as 30 in., and the Atlas Cement Plant, also at Gary, which settled as little as 3 in. He pointed out that the low-cost housing project illustrated what can happen when unknown foundation conditions exist beneath even the smallest of structures. Interestingly enough, the excessive settlement was caused by the consolidation of an organic silt layer due to the weight of the sand backfill used to level the area rather than to the light structural load. In contrast, the Atlas plant illustrates the ultimate economy of an adequate soil-boring program.

Industrial and construction progress in the intermountain area in 1955 was reviewed at the **Intermountain Section's** December meeting by LeRoy Nelson, vice-president of the First Security Bank. New Section officers, inducted during the meeting, are Dean K. Fuhriman, president; A. Z. Richards, Jr., vice-president; and R. E. Spears, secretary-treasurer.

With all engineers in the area invited to attend the **Kansas Section's** December dinner meeting, there was a turnout of well over a hundred. Principal speaker at the meeting—a joint session at Lawrence with the University of Kansas and Kansas State College Student Chapters—was L. E. Ordelheide, of Haskins, Riddle & Sharp, Kansas City, who spoke on the

New Kentucky Section officers—installed at meeting in Frankfort on December 9—are shown in top photo. Seated, left to right, are W. B. Drake, vice-president, and John E. Heer, Jr., president. Standing are Calvin G. Grayson, corresponding secretary, and William L. Echstenkamper, secretary-treasurer. In lower view W. W. Sanders (left) presents Life Membership Certificate to C. W. Lovell, charter member and past-president of the Kentucky Section.



New slate of officers takes over at the December 8 meeting of the Central Ohio Section. They are, left to right, Charles B. Smith, first vice-president; Thomas W. Singell, new president; George E. Large, past-president of Section and installation officer; Robert W. Duis, secretary-treasurer; and Roy T. Underwood, second vice-president.

Puerto Rico Section installs 1956 officers at banquet at Hotel Condado, San Juan, December 22. Shown in usual order are William C. Hill, past-president of Section; Mrs. Hill; Mrs. Jose M. Canals; Jorge J. Jimenez, president for 1956; Jose M. Canals, retiring president (1955); Mrs. Jimenez; Mrs. Stanley G. Kadala; and Stanley G. Kadala, incoming first vice-president.

metropolitan approach to fringe sanitary problems.

Maine highway experts were out in full force for the **Maine Section's** sixth annual highway conference, held at the University of Maine, December 16 and 17. Cooperating with the Section in a program primarily concerned with safety and maintenance problems were the State Highway Commission and the Student Chapter at the university. Of special interest were data from federal highway studies, presented by H. A. Radzikowski, chief of the maintenance branch of the U. S. Bureau of Public Roads, Washington. Mr. Radzikowski emphasized that new methods of maintenance must be adopted for the new superhighways such as the Maine Turnpike. Drivers on such roads are likely to be "intolerant of anything obstructing the roadway. They feel that they have the right of way," he asserted. He also explained that ordinary signs warning of construction work are being found inadequate on high-speed roads and that motorists are likely to run into them rather than heed them. To meet the situation, he suggested maintenance of such roads on a 24-hour basis so there will be as little obstruction of the highway as possible. Favoring preventive maintenance, Mr. Radzikowski cited figures showing that higher building costs can be made up in lower maintenance requirements throughout pavement life.

In a timely talk on hurricanes given at the **Maryland Section's** November meeting, George S. Benton, associate professor of civil engineering at Johns Hopkins University, confirmed the general impression that the hurricane path has changed. With the northeastern United States likely to have more and worse hurricanes, Dr. Benton's talk had a warning for "design engineers who are at present basing their structural and storm water designs on outmoded data." At the December meeting certificates of life membership were presented to Wilson T. Ballard, John M. Russell, Frederick B. Siems, Charles E. Sloan, and Harry Williar. In the annual election of officers W. W. Pagon was chosen president, and C. L. Kroll vice-president. W. W. Ewell continues as secretary-treasurer for another year.

The **Miami Section** also elected new officers in December—H. J. Morrison, president; August De Winkler, Jr., vice-president; Karl G. Frese, Jr., secretary; and James O. Power, treasurer. Guest speaker at the December meeting was local architect Robert Fitch Smith, who contrasted interesting new buildings in Central and South America with the Inca ruins in Peru.

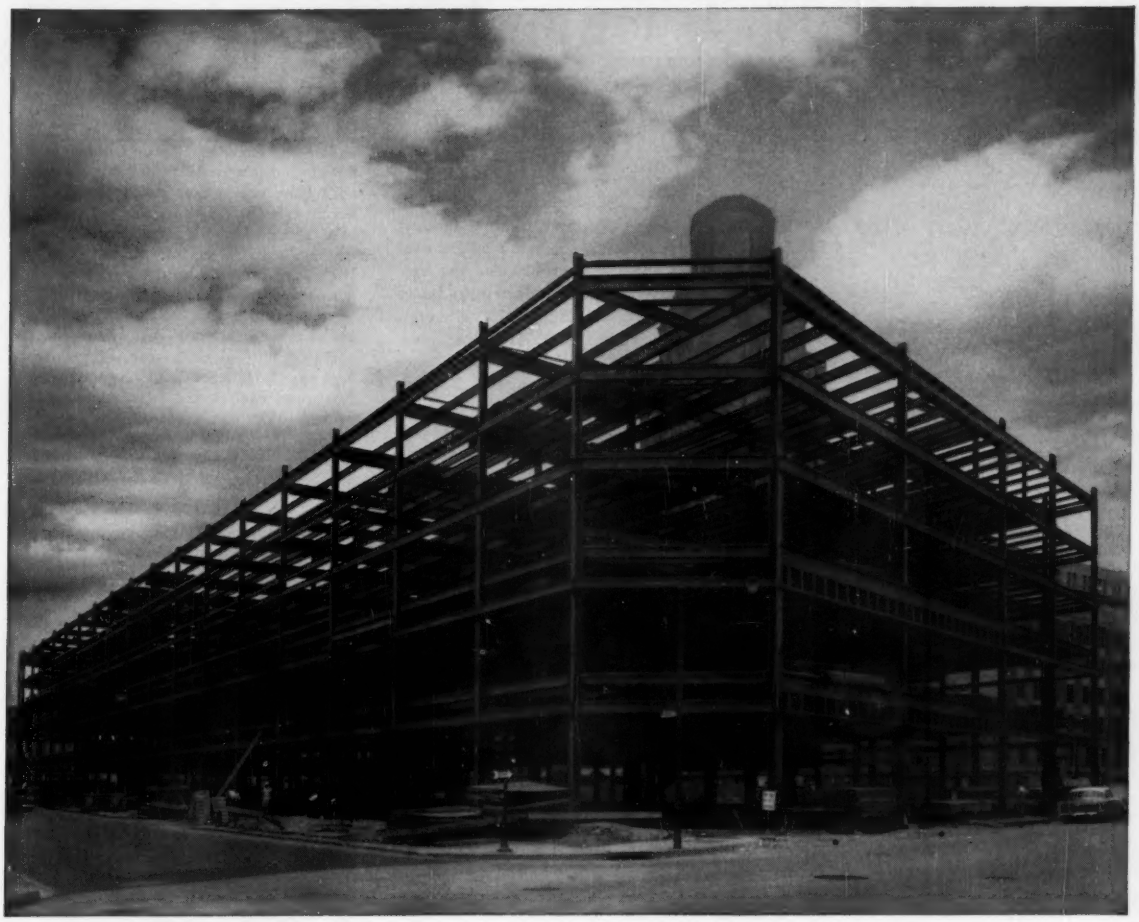
The new **Michigan Section** officers are Fred H. Burley, president; Louis D. Kirshner, first vice-president; Lloyd T. Cheney, second vice-president; and Joseph N. Karwecki, secretary-treasurer.

Vicksburg's plans for new parks and playgrounds were revealed at a recent meeting of the **Mid-South Section's Vicksburg Branch** by H. H. Landrum, group manager for the Southern Bell Telephone and Telegraph Co., and featured speaker. As chairman of the local Park Commission, Mr. Landrum has been making a study of the city's outdoor recreational facilities and helping plan new ones. The **Memphis Branch** reports that its new officers are Fred C. Walpole, president; J. Irby Seay, Jr., vice-president; and W. B. Faulkner, secretary-treasurer.

"The Civil Engineer in the Nation's Capital" is the promising title of a newsletter with which the **National Capital Section** greets the new year. The first issue promises to keep members informed of Section and Society doings of interest, news of engineers, and special engineering news, and asks the cooperation of members in supplying information.

At the **New Mexico Section's** annual meeting, held in Santa Fe on December 10, Robert E. Cron, Jr., district engineer for the Albuquerque district of the Corps of Engineers, discussed the test track at Holloman Air Base, on which the spectacular and world-famous deceleration tests were made. Dr. William R. Lovelace II, of Albuquerque, spoke on peaceful uses of atomic energy at the dinner meeting concluding the all-day session.

The **Northwestern Section's** December meeting honored new Life Members Archer W. Bedell and Gordon P. Smith. Both spoke briefly after receiving their certificates. Section officers for 1956, unanimously elected during the meeting, are F. W. Thorstenson president; J. E. Fant and C. H. Prior, vice-presidents; and Norman Henning, secretary-treasurer. With the ladies of the Section present as guests, the almost universally appealing topic of "gardening" was the subject of the evening. George Luxton, garden editor of the *Minneapolis Tribune*, was the speaker.



3500 tons of steel erected in less than 5 weeks

This is the corner of Fifth and Federal Streets in Camden, N. J. Some weeks before this photograph was taken you would have had an unobstructed view of City Hall from this spot. Then, on July 11, 1955, Bethlehem erection crews moved in. Using three 50-ton cranes and one 60-ton crane, all with 100-ft booms, they quickly placed the steel for the five-story framework shown here, averaging well over 100 tons per working day. They completed erection of the 3500-ton structure on August 11—in less than five weeks!

Bethlehem two-man crews finished bolting within two days after the last of the steel had been put into place.

A number of factors account for the fast erection time: accurately fabricated structural steel delivered on schedule, smooth coordination on the job, and the use of A-325 high-strength structural bolts. Some 31,700 Bethlehem high-strength bolts were used for the stressed joints made in the field. This technique, pioneered by Bethlehem, proved more economical, faster and quieter than riveting; required less men, and resulted in tighter joints.

The completed building, known as the Parkade, will have shops and offices on the first two floors. The upper floors are to be used for parking. *Owner:* Nedmac Associates, Inc. *Architect:* Ziegler, Childs & Paulsen, Jersey City. *Structural Engineers:* Lars I. Moe & Son, Jersey City. *General Contractor:* Terminal Construction Corporation, Woodridge, New Jersey.

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D. B. Steinman (center) New York City consultant and widely famed bridge engineer, is guest of honor and principal speaker at joint meeting of the Indiana Section's Northwest Branch and the University of Notre Dame Student Chapter, held at Notre Dame. He is shown here with Karl E. Schoenherr (left), dean of the civil engineering department, and John T. Massman, president of the Chapter.

More efficient power generation, making use of conventional fuels (coal and oil), is our crying need today, power-wise. This is the opinion of Lew Beatty, assistant board chairman of the Philadelphia Electric Co., given at the **Philadelphia Section's** December meeting—an impressive joint gathering with local groups of the ASME and the AIEE. Contrary to popular belief, said Mr. Beatty, atomic fuels will not solve the colossal power needs created by projected industrial expansion and population increase (200,000,000 by 1975). Atomic fuels will supply approximately one-third of the total, based on anticipated developments. K. M. Irwin, vice-president of the Philadelphia Electric Co., showed graphically how more efficient power generation has been the guiding star of electrical engineers. Watt's steam engine with its output of 130 kwhr per ton of coal, a sensation in 1739, has given way to turbo-generators now under construction by the Philadelphia Electric Co., which can produce 3,450 kwhr per ton of coal.

An insight into the problems involved in enforcing and administering the Civil Engineers Registration Act was given at the November meeting of the **Sacramento Section's Central Valley Branch.** William A. White, executive secretary of the State Board of Registration for Civil and Professional Engineers, was guest speaker. We pay for good roads whether we have them or not, Paul C. Sheridan, assistant district engineer, California Division of Highways, told members of the **Marysville Branch** at a recent meeting devoted to "road blocks." Mr. Sheridan went on to explain that "consumer costs are reflected in transportation charges over poor roads. If a proposed highway could eliminate ten stop signs on the route of an average trip, the savings in gasoline realized would pay the tax on the gasoline required for the trip." The **Nevada Branch** has installed its 1956 officers: E. W. McKenzie, president; Elmo DeRicco, vice-president; and Wallace Rabenstine, secretary-treasurer.

The **San Diego Section** planned its December meeting without a technical program in order to give old and new members a chance to get better acquainted. However, several members were asked for an opinion as to the outstanding local project of the past year, which led to informal discussion of the $6,000,000 Federal Boulevard Freeway and the recently completed $30,000,000 San Diego Aqueduct.

Sophomore Indoctrination Smoker—sponsored by the Student Chapter at Brooklyn Polytechnic Institute—is fast becoming a tradition in the civil engineering department. Some 150 students attended this year, and 40 were inducted into the Chapter. B.P.I. Smoker was instituted in 1950 by Louis Pignatero, then president of the Chapter and now a member of the faculty.

Harold A. Cotton, veteran employee of the Coast and Geodetic Survey, received a Life Membership Certificate.

The **San Francisco Section,** oldest in the Society, celebrated its fiftieth birthday with brief ceremonies during its December 20 meeting. In the featured technical talk Harmer T. Davis, member of the ASCE Task Committee on the National Highway Program and director of the University of California's Institute of Transportation and Traffic Engineering, discussed engineering and financial aspects of the federal system of interstate highways. The Section's recently formed **San Jose Branch** has been officially approved. Branch officers for 1956 are Stanley J. Kocal, president; Charles L. Coburn, vice-president; and Myron M. Jacobs, secretary-treasurer.

Three Inland Empire engineers were awarded Life Membership Certificates at a meeting of the **Spokane Section** on December 7. They were Benjamin J. Garnett, Spokane city engineer; Fred M. Berry, Wenatchee; and Fred J. Sharkey, Coulee Dam, Wash. Chester A. Moore, head of the civil engineering department at the University of Idaho, was elected president for 1956. Other new officers are W. W. Wilson and Edwin Nasburg, vice-presidents, and John Mangan, secretary-treasurer. ASCE Director Louis E. Rydell, of Walla Walla, was featured speaker.

At the helm as president of the **Tennessee Valley Section** in 1956 will be George P. Palo, head civil engineer for the TVA at Knoxville. Henry C. Peeples, property and supply officer and materials engineer in the Power Construction Branch of the TVA at Chattanooga, is new vice-president. Hugh B. Henry, head of the TVA's Highway Design Section at Knoxville, was reelected secretary-treasurer.

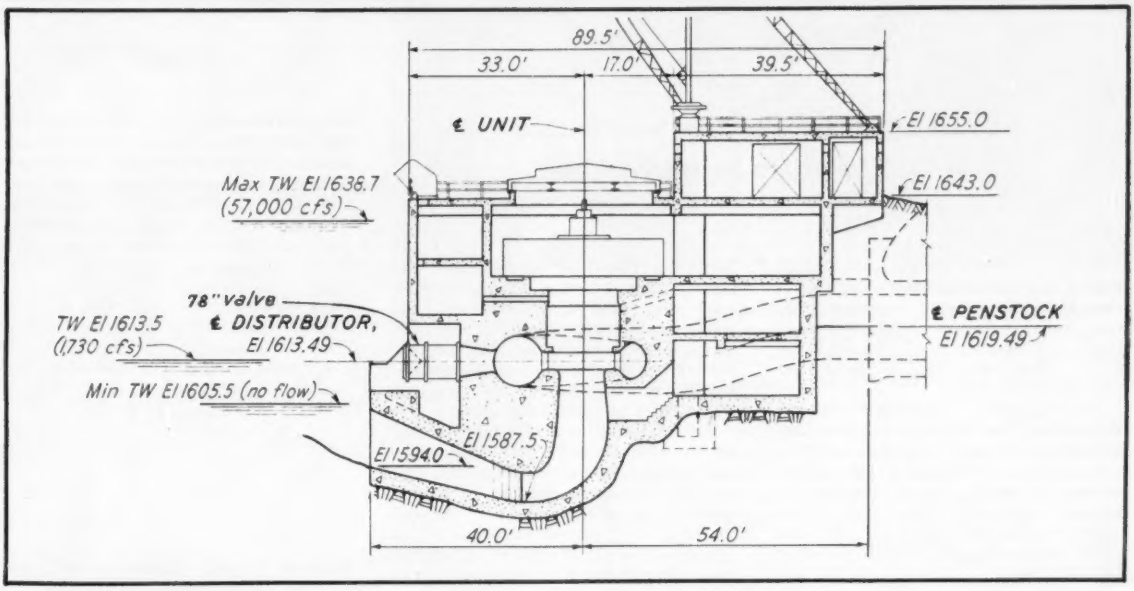
Texas Section members especially interested in hydraulics and hydrology have formed a Hydraulics Group, following Section authorization of the step. Chairman of the Hydraulics Group will be John Montgomery, hydraulic engineer with the U.S. Geological Survey in charge of surface-water investigations in northeast Texas; vice-chairman, W. L. Moore, professor of hydraulics at the University of Texas; and secretary-treasurer, Victor Jaeggli, engineer and manager of the Lower Nueces River Water Supply District, Corpus Christi.

New **Toledo Section** officers are Robert C. Sheldon, president; Rehman P. Scholz, first vice-president; E. Alfred Picardi, second vice-president; and William Gross, secretary-treasurer.

The **Wisconsin Section** will be host to the ASCE Hydraulics Division's next annual meeting. The place will be the University of Wisconsin at Madison, and the dates August 22–24.

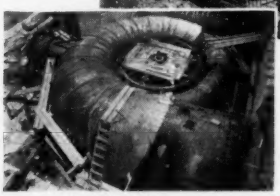
TVA Installs *Another* Leffel Turbine

Nottely Dam Power Plant — a progress report as of the end of 1955



Completely assembled turbine except for riveted scroll case.

Powerhouse and draft tube forms in place.



Assembled scroll case in position from above.

In the new hydroelectric power plant on the Nottely River near Murphy, North Carolina, the TVA is now completing the installation of another efficient Leffel turbine.

Nottely Dam, of the rock and rolled earth fill type, was completed in 1942, without a power unit. Installation of the No. 1 power unit was authorized in 1951 and a Leffel turbine was selected to drive the generator.

The turbine is rated to develop 21,000 HP under a net head of 124 feet at 180 RPM. The specific speed of the turbine at rating is 63.2 RPM. The operating head varies from 76 feet to 166 feet.

Other Leffel turbines installed by the Tennessee Valley Authority are located at Chatuge Dam in North Carolina and Wilbur Dam in Tennessee.

The efficient design and rugged construction of the Nottely unit—backed by 94 years' of experience in the hydraulic turbine field—make it typical of the notable hydraulic turbines built by Leffel for hydroelectric power projects throughout the world.

Leffel engineers are trained in design, construction and adaptation of the turbine which will most efficiently and economically meet the needs of each power plant development, whether it is a completely new installation or part of an expansion of rehabilitation program.

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NEWS BRIEFS . . .

Construction Activity Sets New Record In 1955 for Ninth Successive Year

Spending for new construction in 1955 totaled $42¼ billion, establishing an all-time high for the ninth successive year, according to preliminary joint estimates of the U. S. Departments of Commerce and Labor. Outlays for each month also set new records in 1955.

The total dollar value of new work put in place last year was 12 percent above the 1954 figure and, even after adjustment for price changes, represented the highest volume on record. Private construction expenditures rose 17 percent above the 1954 level to $30¼ billion in 1955, and public outlays edged upward by 2 percent to $12 billion.

Increased residential building was the largest single factor in achieving last year's record rate, accounting for two-thirds of the total dollar gain from 1954. On a seasonally adjusted basis, 1955 expenditures for new private residential building advanced almost steadily until midsummer, reflecting the unusually large number of dwelling units started late in 1954 and still under way in 1955. Private residential building activity for 1955 as a whole reached a new peak of $16.6 billion, nearly a fourth above the previous high of 1954.

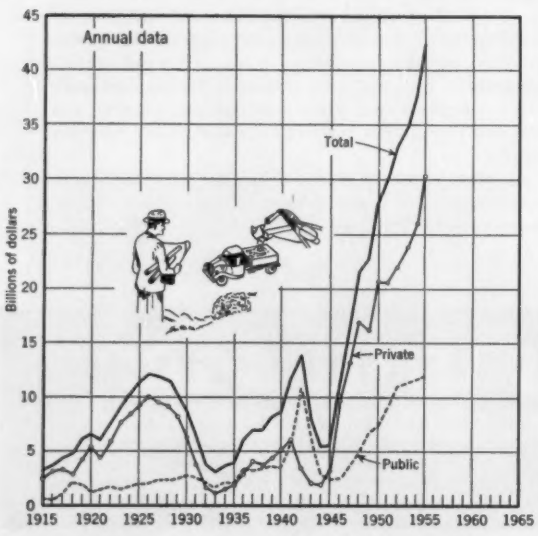
Other types of construction that achieved an unprecedented dollar volume in 1955 were shopping and service establishments, churches, private industrial plants, office buildings, public schools, sewer and water lines, highways, and petroleum pipelines. For all these categories, except industrial building, the 1955 rise represented the third (or more) consecutive increase; for industrial building, it reversed a two-year downtrend.

Expenditures also were greater in 1955 than in 1954 for private hospitals, social and recreational buildings, and military facilities. However, spending for private hospitals was off 16 percent from the peak in 1951 when construction was at its height, and social and recreational building was 9 percent below the all-time high of 1949. Outlays for military facilities almost equalled the postwar high of 1952.

All other major construction categories showed a decline from 1954. These included public industrial building (mainly installations for the AEC), public housing, conservation and development work, farm construction, public hospital facilities, private educational building, and railroad construction.

Except for grants-in-aid programs, federal spending for new construction was down substantially last year. However, the decline was more than offset by increased outlays of state and local funds.

In the closing month of 1955, total new construction activity declined seasonally, with most types of construction remaining strong. The only major categories to show a more than seasonal decrease were commercial building, sewer and water construction and all public nonresidential building, except school construction which declined seasonally. On the other hand, military facilities, highways, and conservation and development work declined less than usual for the time of year. December expenditures for all new construction totaled nearly $3.2 billion—off 12 percent from November, but 3 percent higher than the December 1954 total.



New construction in 1955 totals $42¼ billion, setting an all-time high for the ninth successive year. Total dollar value of new work put in place was 12 percent above last year's total and also represented the highest volume on record.

Heavy Floods Devastate Three Western States

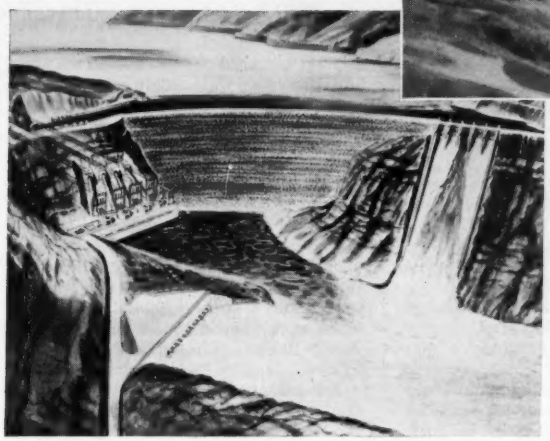
This time it is the Far West that has been hard hit by floods. The floods—centered in northern California, southern Oregon, and parts of Nevada—were caused by heavy rainfall plus melting snow pack in the Sierra watershed. Between December 15 and 27 there were four severe storms, with a total rainfall of 30 in. in some areas. A Feather River levee broke near Yuba City, Calif., which, with surrounding areas in the Sacramento Valley, was hardest hit.

R. Robinson Rowe, Director of the Society and supervising bridge engineer for the State Division of Highways, writes that the "Feather, Yuba, Kaweah, Russian, Eel, Klamath, Trinity, Mad, and Pajaro rivers all set marks higher than ever recorded. For most of those named, marks were higher than the legendary marks of the 1862 deluge."

While such flood control facilities as Shasta, Folsom, Friant, and Pine Flat dams prevented appreciable damage to large cities, including Sacramento and Stockton, several small towns and communities were wiped out and thousands were left homeless. Many of the flood deaths, estimated at 100, occurred at Yuba City. Unofficial estimates place losses at over $100,000,000.

Highway damage is especially great. For instance, in Siskiyou County (California) alone, some 200 miles of roads and 30 bridges were washed out. Damage to power plants was also widespread. The Bureau of Reclamation's Folsom Dam plant was out, as were thirteen of the Pacific Gas & Electric Company's plants with a total capacity of 300,000 kw. As in the Eastern floods of August and October, the Corps of Engineers is directing the work of rehabilitation.

Brownlee Dam—First Hell's Canyon Project



Despite mud and snow, work began in November on Idaho Power Company's new Brownlee Dam Project, 140 miles northwest of Boise, Idaho. Aerial view shows the dam site in the Hell's Canyon stretch of the Snake River, the white line indicating the location of the project. The dam, shown here in artist's conception, will be one of the fifteen highest in the world. The reservoir will be 57 miles long and will have a storage capacity of 1,500,000 acre-ft. The river will be diverted in July 1956, and completion of the dam is scheduled for May 1958. The project, which will cost about $63,000,000, will generate 360,000 kw of power. Federal Power Commission's decision to license construction by the I. P. C. of three low dams in the canyon has been appealed to the U. S. Court of Appeals for the District of Columbia by proponents of one high dam in the canyon. Morrison-Knudsen is the contractor. Illustrations courtesy of Caterpillar Tractor Co.

ARBA Foresees Big Road Program

"Better highways are a desperate national need," Senator Dennis Chavez, New Mexico, chairman of the powerful Senate Committee on Public Works, told the 54th Annual Convention of the American Road Builders Association, which was held at Miami Beach, Fla., January 11–14. The Senator said that he feels Congress is determined to come up with a highway bill based on the pay-as-you-go principle rather than on the long-term bond issue of $21,000,000,000 proposed by the Clay Committee in 1955. This bond issue would mean paying upward of $13,000,000,000 in interest. He said, "a lot of roads can be built for that kind of money."

An air of expectancy could be noted as senators and congressmen spoke to the 1,800 delegates about the financing aspects of the needed road-building program. Congressman George H. Fallon of Maryland, chairman of the Subcommittee on Roads of the House Committee on Public Works, also offered assurance that a multi-billion-dollar highway bill will pass this session of Congress. He, too, favors a pay-as-you-go plan. The main features of his proposal are (1) to add $25,000,000 annually for 12 years, beginning in 1958, to the $750,000,000 program in the Federal Highway Act for primary, secondary, and urban roads. In the twelfth year this would amount to nearly a billion dollars, and the total would approach $10,000,000,000 dollars. The states would match these dollars. (2) In addition, $2,000,000,000 a year, a total of $24,000,000,000, would be provided to complete the interstate system on a 90–10 percent government-state participation basis.

"Our group of highway users is completely devoted to the expanded road plan," said John V. Lawrence, managing director, American Trucking Association, Inc., "in spite of being accused of killing the Fallon Bill in 1955. We'll accept the bond plan, or the bond-with-increased-tax plan, or increased taxes alone," he declared. "Equity demands, however, that each type of highway user be assessed at the same *rate* of taxation." The fuel tax, the rubber taxes, and the excise taxes should be at the same rate for cars, buses and trucks. At the same rate of gas taxes, for example, larger trucks would pay in taxes five times as much as a passenger car, because they use five times as much gas.

ARBA President J. N. Robertson repeated the organization's 1955 conclusions respecting the highway program, which stated that a $68,000,000,000 federal-aid program could be undertaken and successfully completed in ten years insofar as planning, engineering, and construction are concerned, without undue interference with normal construction activity. According to ARBA the problem as a whole is definitely one of finance and not of construction.

Highway engineers, administrators, manufacturers, and constructors in record numbers listened thoughtfully to various plans for best putting the greatly expanded construction program into action, and to suggestions as to how each segment of the highway industry can cooperate to improve engineering methods, and use effectively the materials and machinery needed for road work.

Speaking on the subject of "Increased Highway Engineering Productivity," Harold L. Plummer, chairman, Wisconsin State Highway Commission, emphasized that things that are being done the same way today as they were done ten years ago are being done wrong and wastefully. In 1954 the Wisconsin Highway Department, he said, had 400 engineers and a $42,500,000 highway program—an average of 10 engineers per million dollars of construction. In 1955 it still had 400 engineers and accomplished a $73,000,000

construction program, or an average of 5.5 engineers per million dollars of construction. In 1956 the state's program contemplates $105,000,000 of construction. It will be accomplished with the same number of engineers, an average of less than 4 engineers per million dollars of construction. In the United States there are 32,000 highway engineers currently at work on a $4,000,000,000 per year highway program, or 8 engineers per million dollars of construction. If this can be cut to 4 engineers per million dollars of construction, then an $8,000,000,000 program each year can be handled. He believes it can be done.

To approach this in Wisconsin, engineers have been relieved of all but engineering work. The number of non-professional men employed has been increased to 3 or 4 for each engineer. Training programs have developed personnel for survey parties so that they operate almost entirely without engineering help. Just one engineer supervises seven parties. Photogrammetry has cut the plan preparation time from one year to four months. Plans have been simplified to eliminate every unnecessary detail. All unnecessary time-consuming details of administration are being discarded; larger contracts are awarded; and a two-year advance-planning schedule is in operation.

Since the supply of engineers is limited, Mr. Plummer's department has determined that it must keep the engineers it has, but to do this salary alone is not enough. In order of importance the following are factors in keeping satisfied engineers on the job: Challenging work; career advancement on the basis of demonstrated capability; training programs; adequate pay and pay raises; liberal vacation and leave policy; a retirement system; and professional recognition.

A panel of speakers on steel in pavements concluded that concrete pavement should be longitudinally reinforced, 0.5 percent of longitudinal steel and 8-in. thickness of slab being enough. A continuously reinforced slab, without joints except at the end of the day's work, provides "a pavement that is smooth, free from faulting, free from pumping, structurally uniform, free from open cracks, stable as to movement along the subgrade and free from the major maintenance necessary at joints." Such a pavement can be laid safely on less thickness of granular subbase and at a total cost close to that of current high-type unreinforced pavements. Since the cost of the pavement averages only about 12 percent of the whole cost of a highway it appeared to the speakers that a small increase in the pavement cost is warranted in order to obtain wider use of more durable continuously reinforced pavements.

JOHN N. ROBERTSON
President of ARBA

Wire fabric in bituminous resurfacing of unreinforced concrete roads has proved satisfactory in reducing reflected cracks above cracks in the concrete. On the resurfacing of 16th St. in Washington, D.C., reflecting cracking was reduced by 75 percent by reinforcing the bituminous surfacing. In practice the mesh generally is laid in sheets on the old concrete before the surfacing is spread and rolled. The mesh rises to about mid position in the coating.

Other technical papers covered the stabilization of soil with sodium chloride, with cement, and with asphalt; street lighting; education for construction; roadside improvements; and the use of aerial mapping methods for highway location surveys.

Under the same roof with the Convention, held in the great Miami Beach Municipal Auditorium, was a large display of materials and supplies, used in highway construction, supplied by more than 50 exhibitors. It proved so popular that an even larger exhibit of materials and supplies is to be made a part of the ARBA Road Show to be held next year in Chicago, January 28–February 2, 1957.

Executive direction of ARBA will be taken over by Maj. Gen. Louis W. Prentiss on May 1, succeeding Lt. Gen. Eugene Reybold (USA Ret), World War II Chief of Engineers and executive vice-president of ARBA since 1950. General Prentiss retires after 35 years of distinguished military service on April 30. He served as Engineer-Commissioner of the District of Columbia in 1953 and 1954 and since then has been in command of the Engineer Center at Fort Belvoir, Va.

Engineer-Contractor Group Sees Good Year Ahead

At a recent meeting of the National Constructors Association certain bright spots in next year's construction picture became apparent. T. C. Williams, president of the organization, stated that in the expanding industrial construction field, utilities promise the greatest activity in the coming year. In his opinion this expansion in basic power sources will be reflected in other industries in the future. Chemical process plants also present a bright picture, according to Mr. Williams.

Although steel supplies are expected to remain tight if not as bad as in the past year, plans recently announced by the steel industry indicated that this condition would be improved in the future. It was also noted by Mr. Williams that the competition from foreign manufacturers for the installed equipment markets is becoming more significant in the planning of major projects.

The National Construction Association is an organization of major engineer-contractors engaged in the design and construction of heavy industrial installations where plant-processing equipment is a major part of the structural features.

New San Francisco Bay Crossing Found Feasible

The proposed southern crossing of San Francisco Bay is sound from both the engineering and financial viewpoint, according to two-year feasibility studies recently completed by the California Department of Public Works for the California Toll Bridge Authority. Cost of the Alameda-Army Street crossing, which was authorized by legislative action in 1953, is estimated at almost $250,000,000 —of which $100,000,000 will go for a 17 mile system of approaches. The method of financing will be settled by the legislature in an early session.

While the $7\frac{1}{2}$-mile crossing proper will consist largely of trestle, three two-lane subaqueous tubes will be required to carry traffic under the ship channel. Each two-lane tube will be made up of 29 sections of 37-ft outside diameter. The sections will be cast in dry dock and floated to the site. Before the subaqueous tubes can be laid on the bottom of the bay, mud will have to be dredged out and replaced with sand. Sand islands, built at each end of the tubes, will support the ventilation buildings and provide for travel between trestle and tube.

N. C. Raab, M. ASCE, directed the studies for the Department of Public Works' Division of Toll Crossings, of which he is chief. Charles E. Andrew, O. J. Porter, and Ralph Smillie, all Members ASCE, were the engineering consultants, and Coverdale & Colpitts the traffic and financial consultants.

Highway Research Board Holds 35th Annual Meeting

In its thirty-five years of existence the Highway Research Board has expanded its operations to such an extent that the executive committee is debating the advisability of finding a name for it that will be more indicative of its broadened scope. This is what G. Donald Kennedy, M. ASCE, executive vice-president of the Portland Cement Association, told the opening session of the Board's thirty-fifth annual meeting, which was held in Washington, January 17–20.

As cases in point Mr. Kennedy, who was meeting chairman, cited two new projects that got under way during the past year. A Committee on Urbanization was formed for research into the many problems of American cities. Though the study will stress highway transportation, it will also include all the complex and interrelated problems of modern urban living. A special Committee on Airfield Pavements —appointed at the request of the Defense Department—is studying the effect of jet aircraft heat, blast and spillage on airfield pavements.

An important new program of the Board that will have tremendous influence on future highway programs is a new AASHO road test. The test road for this program will be built near Ottawa, Ill. It will be constructed as a federal-aid project, reverting to the Illinois Division of Highways when the test is over. Mr. Kennedy said that the project has been under study for three years and may require five more. Its total cost will be in the neighborhood of $12,000,000. A field office has been set up at Ottawa, and the field engineer, William N. Carey, Jr., A.M. ASCE, has been in residence there since last August, developing test procedures and instrumentation.

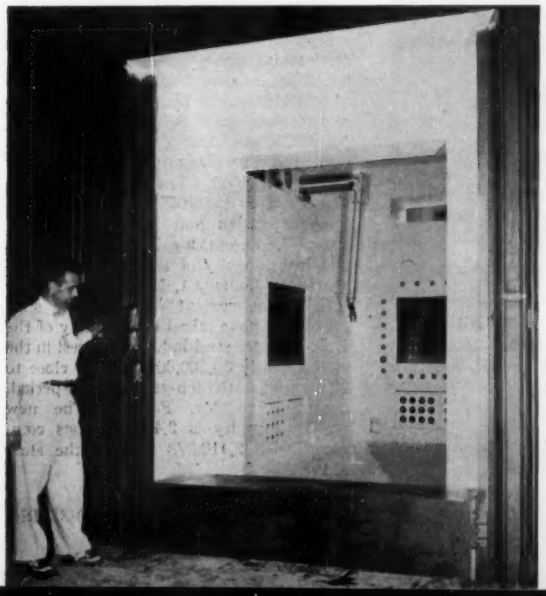
In an interesting talk on the Civil Works program of the Corps of Engineers in its relationship to highway problems, Lt. Gen. S. D. Sturgis, Jr., M. ASCE, Chief of Engineers, U. S. Army, said that the modern highway program (in effect since the end of World War I) has "presented us with an economic tool and a military program which today is among the principal bulwarks of prosperity and defense." General Sturgis also remarked that the 1955 flood disasters "brought home to us the close relationship between adequate highway facilities and flood protection, including the bearing which flood control has upon highway costs, . . . and proved again that plans for road construction should in every case be coordinated with flood-control plans. In fact, such plans can be greatly facilitated and made feasible by the timely development of flood-control systems."

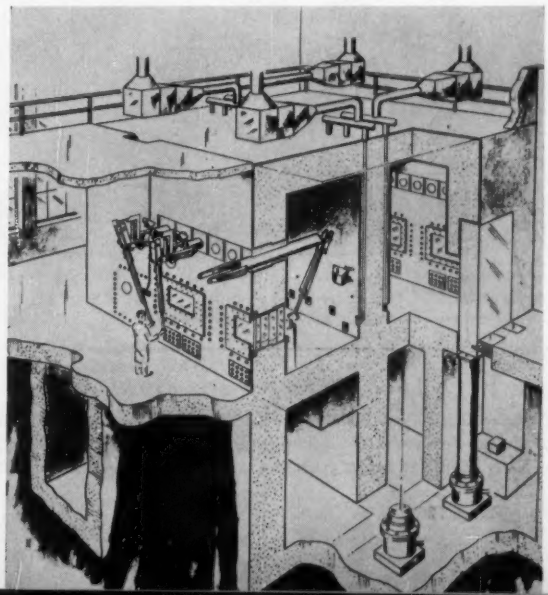
In all there were 36 separate sessions arranged by the Board's six departments. The 200-odd papers covered new developments in economics, finance, and administration; materials and construction; maintenance; traffic and operations; and soils investigations. In addition, there were 67 committee meetings.

At the opening session three of the country's leading highway engineers were presented with the Roy W. Crum Award for "outstanding research achievement." They are Earl F. Kelley, chief of the Physical Research Branch, U. S. Bureau of Public Roads, Washington; Tilton E. Shelburne, M. ASCE, director of research, Virginia Department of Highways, University of Virginia, Charlottesville, Va.; and Stanton Walker, director of engineering, National Sand and Gravel Association, Washington. The Highway Research Board Award for an outstanding technical paper went to Carl C. Saal, of the U. S. Bureau of Public Roads.

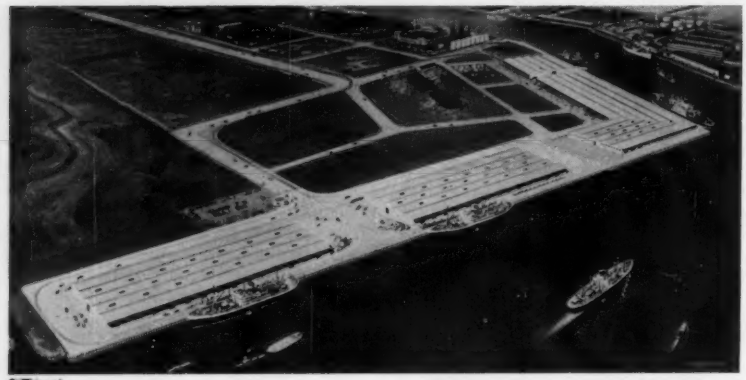
Battelle Institute Has Atomic Energy Research Center

In left-hand view G. C. Calkins, chief of Battelle Institute's radioisotopes and radiation division, raises 20-ton solid steel door of one of two hot cells the Institute is putting into operation for government and industrial research on a 400-acre site near Columbus, Ohio. The "hot cell" laboratory, first of its capacity to be built without federal funds, is designed for the safe handling of large quantities of highly radioactive materials. Door is 18 in. thick and provides protection against radiation up to 10,000,000 curies of gamma-ray-emitting materials. Cutaway sketch at right shows relationship of two Battelle hot cells to their respective subterranean chambers. Lower chambers will be used for experiments with radioactive materials that do not need direct viewing. Hydraulic rams at the right end of the cells raise and lower the two steel doors weighing 13 and 20 tons each. Above the cells is a ventilation and air-purification system. The third unit in the Institute's $3,500,000 atomic research center will be a swimming-pool-type research reactor, which is expected to "go critical" this spring.





Port Authority to Build Marine Terminal at Newark



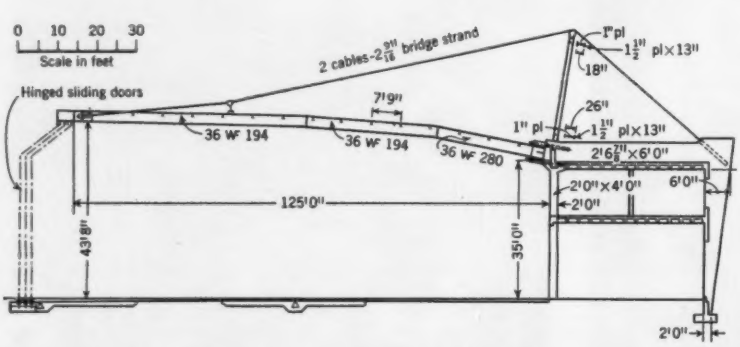
Shown here in artist's rendering is $9,300,000 four-berth marine terminal, to be built by the Port of New York Authority at Port Newark. The project will consist of a 2,400-ft-long wharf; two transit sheds, 800 ft long by 200 ft wide; a two-story air-conditioned office building; and a 400-car parking area. Construction is beginning February 1, with completion scheduled for July 1, 1957. The terminal, which is part of the Port Authority's new $136,000,000 waterfront improvement program, will be occupied by Norton, Lilly & Co. under a ten-year lease.

Philadelphia Airport to Have Unique Hangar

Fabrication of an unusual maintenance hangar for the City of Philadelphia will start next month at the city's International Airport. The project features a cantilever-type roof, extending 129 ft 6 in. from a concrete bent. The entire roof will be supported by 20 cables, each $2^{9}/_{16}$ in. in dia and developing a breaking strength of 392 tons. Under operating conditions the roof is designed to rise 12 in. or drop 14 in. from normal position.

A 28-ft-high cable post, consisting of 24 × 1-in. web plates and 13 × $1^{1}/_{2}$-in. flange plates, will be supported on the concrete anchorage. The post will support steel saddles, on which the cables will rest. The cables will be anchored by 4-in.-dia high-strength studs, one at each end of the cable.

Ammann & Whitney, of New York, are the structural engineers, and the Ballinger Co., of Philadelphia, the architect-engineer. The general contractor is the Baton Construction Corp., of Philadelphia. Steel is being fabricated by the Lehigh Structural Steel Co., Allentown, Pa.



Cross section of new Philadelphia hangar shows unusual combination of steel cantilever and concrete abutment. Inside length of 270 ft consists of nine 30-ft open bays. Inside width is 133 ft, and height graduates from 38 ft at the back to 45 ft at the front.

World Power Conference to Be Held in Vienna in June

Engineers interested in attending the Fifth World Power Conference—to be held in Vienna, June 17–23—should make arrangements at once through the United States National Committee of the World Power Conference. The general program, application and registration forms, and other important information are now available from the Committee. Requests should be sent to Stewart E. Reimel, Secretary, U. S. National Committee, 29 West 39th Street, New York 18, N.Y. Arrangements for transatlantic travel, post-convention excursions, and hotel accommodations may be made through J. M. Benneward, Manager, Convention Department, Thomas Cook & Son, 587 Fifth Avenue, New York 17, N.Y.

The 300 papers devoted to the conference theme, "World Energy Resources in the Light of Recent Technical and Economic Development," will be summarized only in the technical sessions in order to save as much time as possible for discussion. The General Reports will be preprinted in the three working languages of the conference.

Arrangements have been made for a number of tours to power plants and other interesting installations, which will take place at the conclusion of the conference. These tours will include visits to places of historical and cultural interest, and will take the group through some of the most beautiful scenery in Austria. To show the significance of the Central European power distribution system, some of the tours will take in plants in the frontier areas of Germany, Italy, and Yugoslavia.

Steelmaking Capacity Sets New Record in 1955

For the ninth year in succession, steel companies have increased the annual steelmaking capacity of the United States, which on January 1 was at a record high of 128,363,090 net tons. This announcement comes from Benjamin F. Fairless, M. ASCE, president of the American Iron and Steel Institute and retired president of U. S. Steel. The new capacity—attributed to the steel companies' large-scale expansion and improvement programs—represents a gain of 2,534,780 tons over the capacity of 125,828,310 tons reported on January 1, 1955.

With the current increase, the steel companies have raised the capacity of the United States steel industry, largest in the world, nearly 36,500,000 tons, or close to 40 percent, in the ten-year postwar period, according to Mr. Fairless. The new weekly capacity is 2,461,893 tons compared with 2,413,278 tons at the start of 1955.

Armco to Prefabricate Truss-Type Steel Buildings

Plans for a completely new product and a new plant for producing it on a large scale are announced by Armco Drainage & Metal Products, Inc., a subsidiary of Armco Steel Corp. Construction of a $1,500,000 plant will begin immediately at the company's headquarters at Middletown, Ohio. When completed next summer, the plant will manufacture a new line of prefabricated, truss-type, steel buildings.

Supplementing the company's present line of prefabricated Steelox Buildings, the new structures will be available in clear-span widths up to 100 ft and in unlimited lengths. Truss members of cold formed steel will be used in place of heavy, hot rolled structural shapes. The unique shape of the truss members will provide more strength per pound of metal than conventional shapes.

Contract for Newark Insurance Building

The Mutual Benefit Life Insurance Co. announces the award of a low-bid contract for construction of its $10,000,000 home office building in downtown Newark to the George A. Fuller Co. Excavation and foundation work is practically finished, and steel erection is scheduled to start early in February and be completed in the next seventeen weeks. Completion of the entire 20-story building is planned for the summer of 1957. To speed the project, the steel frames will be machine bolted instead of riveted, and concrete pouring and other secondary construction will be under way on the lower floors while steel is being set on the higher floors.

Weiskopf & Pickworth, New York consultants, are the structural engineers, and Spencer, White & Prentis, Inc., engineers on the excavation and foundation. Eggers & Higgins, of New York, are the architects.

Small Cities Ahead in Pollution Abatement Work

Contracts for 185 stream-pollution-abatement projects costing $61.8 million were awarded by municipalities during the third quarter of 1955, the U. S. Public Health Service reports. Of contracts reported, 98 went for new sewage treatment plants and 87 for replacement or improvement of existing plants.

Of the 98 new plants, all but seven will serve communities of less than 25,000 population, and 79 are for towns of less than 5,000. New plant construction for the larger population centers, however, accounts for 41.4 percent of the total dollar cost. The seven larger contracts were awarded by Paducah, Ky.; Las Vegas, Nev.; Middlesex County Sewerage Authority, New Jersey; Johnson City, Tenn.; Kingsport, Tenn.; Fort Lewis, Wash.; and King County Sanitary District, Washington.

The number of sewage-treatment contracts during the third quarter was down from the previous quarter, but the dollar value showed a substantial increase. Figures for the second quarter were 213 projects costing $51.2 million.

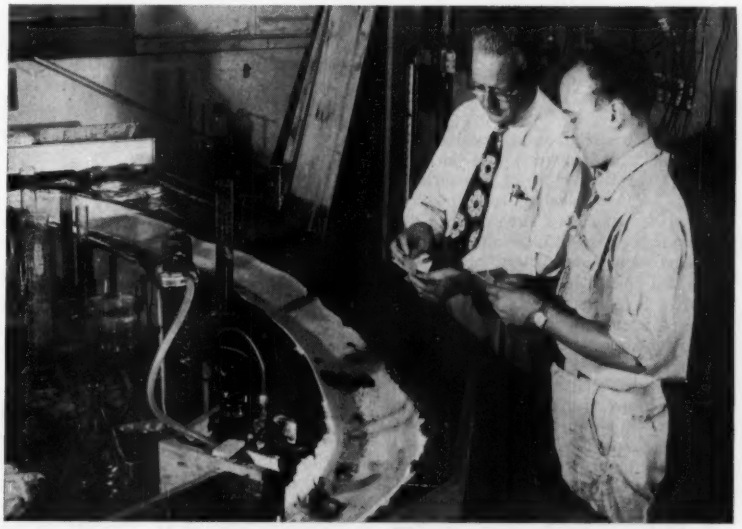
Texas Engineers Attack Problem of Evaporation

Each year Texas is losing almost as much water from reservoir evaporation as it uses. This alarming situation was discussed at a water evaporation organizational conference held at Southwest Research Institute, San Antonio, in December. Louis Koenig, water conservation expert and vice-president of the Institute, told the group of representatives of river authorities and water districts that Texas is losing about 7,000,000 acre-ft of water by reservoir evaporation each year. Total water use in the state is 8,000,000 acre-ft, he said.

Dr. Koenig proposed that further research be made on a thin (one-ten-millionth of an inch) chemical coating for reservoirs to check evaporation. The thin film coating is non-injurious to aquatic life and has no effect on the use of water for municipal, industrial, or agricultural purposes. Dr. Koenig noted that the method has been tried out in Australia for several years with encouraging results. Institute engineers have estimated that water could be saved by this method at a cost of less than 80 cents per acre-ft—"the cheapest reservoir water in Texas."

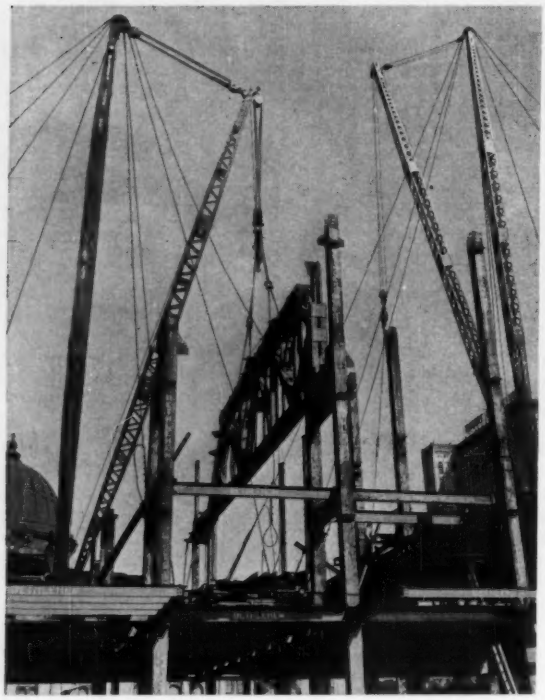
To help solve the evaporation problem, the conference organized the Southwest Cooperative Project on Control of Evaporation of Reservoir Water. E. V. Spence, A. M. ASCE, general manager of the Colorado River Municipal Water District, Big Spring, Tex., was appointed chairman of a committee that will seek sponsors for the research project.

Cornell Laboratory Project Tests Deflector Jetties



Two-mile stretch of West Virginia river flows in miniature in Cornell University's Hydraulic Engineering Laboratory. The experiment was set up to find ways of keeping debris out of a power plant's water system. The plant—part of the Appalachian Electric Power Company's installation on the Kanawha River near Glasgow, W. Va.—produces power from coal, but uses river water for its cooling system. The Cornell study is testing various designs of deflector jetties, which will be built along a 250-ft stretch of river to keep silt and other foreign matter from clogging the water intake. Prof. Marvin Bogema, A.M. ASCE, who is directing the study, and L. E. Hovi, of the American Gas and Electric Service Corporation, which sponsored it, examine 3-in. models of deflector jetties.

High-Strength Bolts Used on Philadelphia Project



Erection of this 53-ton steel truss (center) in the new Sheraton Hotel, Philadelphia, marks advent of high-strength bolts in the Construction industry in that city under a recent Building Code amendment authorized by the Philadelphia Board of Building Standards to save construction time. The truss, which is 70 ft long and 16 ft deep, is the first of five which will support the ballroom ceiling and upper floors of the 22-story $14,000,000 hotel in Penn Center. Steel erection is being handled by the Bethlehem Steel Co.

New Canadian Power Goes on Line in 1955

Construction of power plants in Canada proceeded at a vigorous rate in 1955, although the 839,630 hp of new installed capacity was somewhat less then the average for the past five years. The new addition to Canadian hydraulic water power includes 525,000 hp from the Sir Adam Beck-Niagara Generating Station No. 2 of the Ontario Hydroelectric Power Commission, which went on the line in 1955, and brings the total installed capacity of hydraulic plants in the Dominion to 17,531,536 hp.

Other projects also under way during the year will bring an additional 1,000,000-hp capacity into operation in each of the years 1956 and 1957, while other projects totaling some 4,000,000 hp are either in the planning or preliminary construction stage. The building of new thermal-electric plants and extensions also proceeded at a good rate, and many new transmission facilities were being completed.

These estimates are revealed in the Water Resources Branch's annual report of water-power development, identified as Bulletin No. 2476 and available from the Director, Water Resources Branch, Ottawa, Canada.

NUCLEAR NOTES

XVIII—Calculations for Design of Shielding

The subject of shielding—begun in Chapter XV, published in the November issue—has been continued in subsequent chapters. This installment, also by R. H. Ritchie, presents some examples of shielding design. "Nuclear Notes" appears monthly under supervision of the Sanitary Engineering Division's Committee on Sanitary Engineering Aspects of Nuclear Energy, of which Conrad P. Straub is chairman. The other members of the committee are Earnest F. Gloyna, A. E. Gorman, Prof. Warren J. Kaufman, Alexander Rihm, Jr., and James G. Terrill, Jr.

To illustrate the principles discussed in the January installment, let us solve the following problems: (1) Find the thickness of lead shield necessary to reduce the dose rate to maximum permissible level (7.5 mr/hr) at one meter from a 1-curie Co^{60} source.

It is known[1] that Co^{60} emits two gamma rays per disintegration, having energies of 1.17 and 1.33 Mev. Hence the source emits 3.7×10^{10} photons of each energy per second. The photon flux of either energy at 1 meter from the source without any shielding will then be

$$\phi = \frac{S}{4\pi r^2} = \frac{3.7 \times 10^{10}}{4\pi \times (100)^2} = 2.94 \times 10^{5} \text{ photons/cm}^2 \text{ sec}$$

From Fig. 2 [January installment] the mass absorption coefficients of Pb corresponding to the 1.17 and 1.33 photon energies are 0.063 cm^2/g and 0.057 cm^2/g, respectively. Assuming a density of 11.35 g/cm^2 for Pb, we find $\mu_1 = 0.715$ cm^{-1} and $\mu_2 = 0.647$ cm^{-1}, respectively. To find the requisite thickness of lead, we must now proceed in a cut-and-try fashion. Considering the 1.33-Mev photon, which has the smaller absorption coefficient, we ask what thickness of lead is necessary (considering only exponential attenuation) to decrease the dose rate from 0.677 r/hr to $\frac{1}{2} \times 7.5 \times 10^{-3}$ r/hr. The figure of 0.677 r/hr is the dose due to the 1.33 Mev photons above at the specified distance, that is,

$$2.94 \times 10^{5} \frac{\text{photons}}{\text{cm}^2 \text{ sec}} \times D(1.33 \text{ Mev}) = 2.94 \times 10^{5} \times 2.3 \times 10^{-6} = 0.677 \text{ r/hr.}$$

Then, $0.677\, e^{-\mu_2 x} = \frac{1}{2} \times 7.5 \times 10^{-3}$

$$e^{-\mu_2 x} = 5.54 \times 10^{-3}$$

or

$$\mu_2 x = 5.20$$

$$x = 8.02 \text{ cm}$$

The buildup factor in Pb from Fig. 4 [January installment] for $\mu_2 x = 5.20$ is approximately 2.55, so we must add more lead to compensate for this. An additional layer Δx which decreases the dose by another factor of 2.5 is found from

$$e^{-\mu_2 \Delta x} = 1/2.55$$

Then

$$\mu_2(x + \Delta x) = 6.13$$

If we now guess a value

$$\mu_2 x = 6.5$$

or

$$x = 10.0 \text{ cm,}$$

we find

$$\text{Dose rate} = 2.94 \times 10^{5} [D(E_1)\, B(\mu_1 x_1 E_1)\, e^{-\mu_1 x} + D(E_2)\, B(\mu_2 x_1 E_2)\, e^{-\mu_2 x}]$$

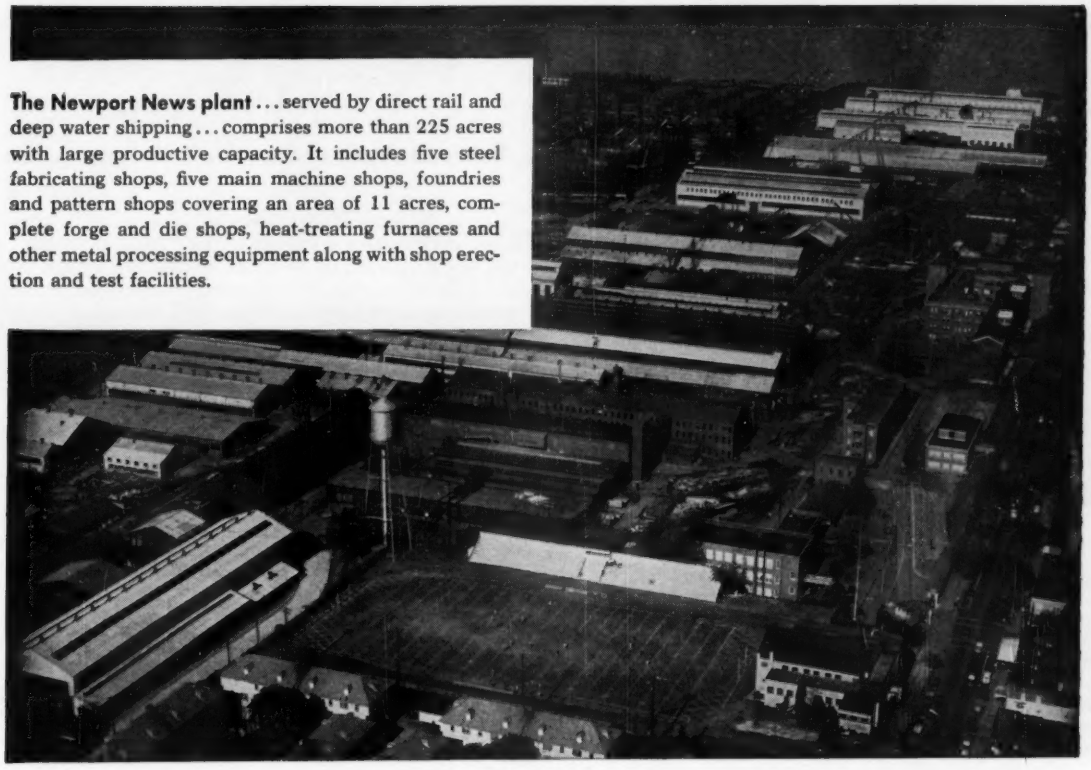
$$= 2.94 \times 10^{5} [D(1.17)\, B(7.15, 1.17 \text{ Mev})\, e^{-7.15} + D(1.33)\, B(6.47, 1.33)\, e^{-6.47}]$$

$$= 4.40 \times 10^{-3} \text{ r/hr}$$

which is lower than the required figure of 7.5×10^{-3} r/hr. However, this thickness may be used for additional safety, particularly since it is suggested that one should not take the limit of 300 mr/week.

Let us now solve another problem using the gamma emitter Na^{24}. (2) Assume that we have a 10-curie source of Na^{24} in

The Newport News plant ... served by direct rail and deep water shipping ... comprises more than 225 acres with large productive capacity. It includes five steel fabricating shops, five main machine shops, foundries and pattern shops covering an area of 11 acres, complete forge and die shops, heat-treating furnaces and other metal processing equipment along with shop erection and test facilities.



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Let Newport News fabricate your weldments or sub-assemblies. Call on us for plate fabrication...from vacuum tanks to bridge caissons ... for pumps, valves, pipe lines ... you'll find that Newport News fabricates parts to answer most demands.

In the vast plant, shown above, Newport News craftsmen complete your orders with specialized production techniques, and with sound experience acquired through construction of thousands of products ranging from small components on rayon spinning machines, to the giant 165,000 hp hydraulic turbines at Grand Coulee.

See for yourself what Newport News is doing, and how this company's high integration of skill and production facilities can help you. Get the facts, shown in *Facilities and Products.* A copy of this illustrated booklet is yours for the asking ... write for it now.

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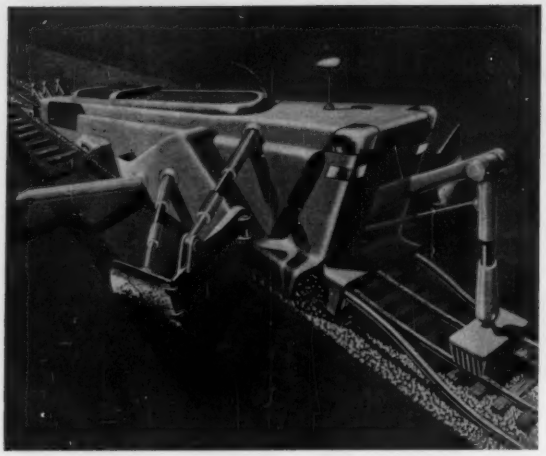


Railroad Maintenance Unit—of the Future

Trains of the future will ride faster and more smoothly with this weird machine as a maintenance unit. Primarily intended to take up old track and lay down new, the machine will also widen and grade the roadbed, ditch for proper drainage, pull and drive spikes, replace old crossties with new ones, and replace and tamp rock ballast under and around the crossties. Photo is taken from the new 16-mm film, "People, Products, and Progress, 1975," recently released by the Chamber of Commerce of the United States.

a barricade composed of ordinary concrete 20 in. thick. What will be the dose rate outside the barricade at 10 ft from the source? Assume that the absorption coefficient of ordinary concrete is the same as that of aluminum.

Na^{24} emits 2 gammas of 1.38 Mev and 2.76 Mev energy in each disintegration.[1] Dose buildup factors for concrete are not available, so we shall use $B(\mu x, E)$ for water, thereby overestimating the dose.

The following values are found from Figs. 1, 2, and 3 [See January installment], assuming that the density of concrete is 2.7:

	E_1 1.38 Mev	E_2 2.76 Mev
μ(cm^{-1})	.140	.0972
μx	7.11	4.94
$B(\mu x, E)$	9.6	4.4
$D(E)$ (r/hr)	2.3×10^{-6}	4.0×10^{-6}

The photon flux of either energy at the point in question neglecting attenuation and buildup is

$$\phi = \frac{10 \times 3.7 \times 10^{10}}{4\pi\,(10 \times 12 \times 2.54)^2}$$

$$= 3.16 \times 10^5 \text{ photons/cm}^2 \text{ sec.}$$

Then the dose rate is given by

$$\text{Dose rate} = 3.16 \times 10^5\,[2.3 \times 10^{-6} \times 9.6 \times e^{-7.11} + 4.0 \times 10^{-6} \times 4.4 \times e^{-4.94}]$$

$$\text{Dose rate} = 45.1 \times 10^{-6} \text{ r/hr.}$$

This is considerably above the maximum permissible value, but may be brought below that value by using a concrete shield only 8 in. thicker.

[1] "Nuclear Data," National Bureau of Standards Circular 499. Obtainable from Supt. of Documents, Government Printing Office, Washington 25, D.C.

N*G*Neare's COLUMN

R. ROBINSON ROWE, M. ASCE

"Somehow," drawled Joe Kerr, "I couldn't get excited about 3 girls who did nothing but play checkers, so maybe I miscopied the problem. Didn't you say that each girl's chance of winning was proportional to her age?"

"I did," admitted Professor Neare.

"And that Beth won 30 percent of the games?"

"Check."

"And that Anne won half as many as Claire? And that Claire was 27? And that you wanted to know 'How old is Anne'?"

"You heard me and copied me."

"Then Anne had to be 13½, and all of this Beth business was the gimmick to confuse me. Or was it?"

"What do you think, Cal?"

"Oh, I've known a long time that Joe was confused," jeered Cal Klater. "I don't have to prove it, but here goes. Suppose we let a and b be the unknown ages of Anne and Beth and n be the number of games each played with each other, making $3n$ games altogether. Beth won 30 percent, or $0.9n$, and the others were divided $0.7n$ to Anne and $1.4n$ to Claire.

"When Anne and Beth play, their chances of winning are proportional to a and b, that is, Anne wins $an/(a+b)$ and Beth wins $bn/(a+b)$. With similar relations for other pairings:

$$an/(a+b) + an/(a+27) = 0.7n \ldots . (1)$$

$$bn/(a+b) + bn/(b+27) = 0.9n \ldots . (2)$$

"Since n cancels out, we have 2 equations in a and b; eliminating b leads to the cubic,

$$91a^3 + 1107a^2 + 21141a = 413343 \ldots (3)$$

which I solved by Horner's method to find $a = 10.0033006$. No doubt you chose the figures 30 percent and 27 carefully so that the answer can be called 10."

"Precisely," agreed the Professor, "altho I couldn't do as well for Beth, whose age is 13.27754. Here's how 300 games would be divided

Winner-/ Loser	Anne	Beth	Claire	Total
Anne.....		43	27	70
Beth.....	57		33	90
Claire.....	73	67		140

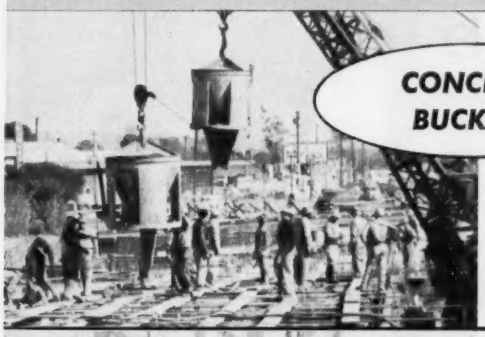
And if you want a real tough problem, take the final averages of the American League and compute the relative probabilities of each of the 8 teams winning from each of the other 7.

"However, that would prove to be a job for Aniac, so I'll assign an easier one from the notebook of Al E. Dayde, the surveyor. He was directed by a probate court to divide an estate of a 160-acre quarter section of land into 4 parcels with areas proportional to ages of minor heirs, these ages being 6, 7, 9 and 10 respectively. Al did it the easy way with two straight lines across the tract intersecting at right angles. Now Joe would like me to ask the area of the smallest parcel, but I want the location of any of the 5 monuments Al had to set."

[Cal Klaters were O'Kay (Otto Koch), Harry Herman, and Thatchrite (Guy C. Thatcher).]

Selection Chart

FOR CONCRETE HANDLING EQUIPMENT



CONCRETE BUCKETS

SELECT FROM 30 different Gar-Bro bucket types and sizes ranging in capacity from ⅓ to 8 cu. yds. There is a Gar-Bro bucket for all concrete mixes and aggregate sizes—standard round or laydown type buckets. Each has Gar-Bro patented, self-closing, grout tight, double clamshell gates.

Type	Capacity (cu. yds.)	Concrete Slump	Aggregate Size (Max.)	No. of Bucket Sizes
LIGHTWEIGHT	⅓ to 1½	Normal	3″	5
STANDARD DUTY	¾ to 4	Low Slump	3″	7
HEAVY DUTY	2 to 8	Dry	6″	9
LAYDOWN	½ to 3	Normal or dry	3″ or 6″	9

CONCRETE HOPPERS

CHOOSE FROM 32 Models of Gar-Bro Hoppers including Receiving Hoppers and Floor Hoppers. They are used by contractors to prevent delay of truck mixer and placing crew. Serve as intermediate storage for concrete.

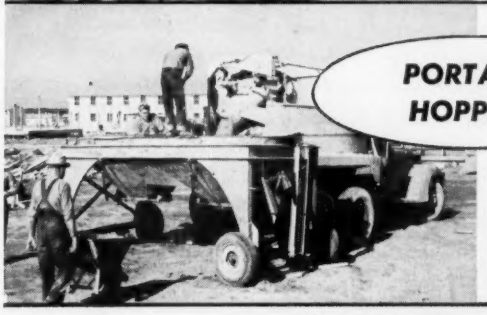
Type	No. of Gates	Cap. (cu. ft.)	Attachments
VERTICAL FRONT	Single	28 to 67	Collars & Stands
CENTER DISCHARGE	Single	32 to 72	Collars & Stands
VERTICAL FRONT	Double	54 to 135	Collars & Stands
CENTER DISCHARGE	Double	63 to 144	Collars & Stands

POWER CARTS CONCRETE CARTS

BUILT FOR HANDLING CONCRETE, these units can move more concrete per day than any ordinary cart. Power-carts have speed, capacity and extra maneuverability. Concrete carts are balanced to man's muscle. See them; compare them!

Equipment	Load Capacity	Maximum Travel Distance	Speed	Capacity* per Hour
POWER-CARTS	12 cu. ft.	1000 ft.	15 mpr.	15 to 20 cu. yds.
CONCRETE CARTS	6 to 8 cu. ft.	200 ft.	walking	3 to 5 cu. yds.

*according to hauling distance



PORTABLE HOPPERS

READY TO MOVE FROM JOB TO JOB these hoppers on wheels serve as concrete supply stations for cart crews; they prevent delay of truck mixers and placing crew. Two types available with either wheels or skids.

Type	No. of Gates	Cap. (cu. yds.)	Type of Gate
PORTABLE	2	2 to 3	Double Clamshell
SEMI-PORTABLE	2	3 to 4	Double Clamshell

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STANDARD METRIC AT $560.00: Reading direct to .1 mm, estimation to .01 mm. Use with Wild precision Invar Rods.

SPECIAL INDUSTRIAL AT $667.00: Reading direct to .001 inch. Use with Wild Stainless Steel Rods, 3′ and 6′ long.

SPECIAL ENGINEER AT $595.00: Reading direct to .0005 ft., estimation to .0001. Use with standard leveling rods.

All models have tilting screw, coincidence level and built-in optical micrometer.

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DECEASED

John Walter Ackerman (M. '08), age 88, retired municipal engineer and a resident of Munnsville, N.Y., died there on November 24. Educated at Cornell University, class of 1897, Mr. Ackerman had been city engineer of Auburn, N. Y., his birthplace (1902–1908); chief engineer and superintendent of the Auburn Water Works (1909–1920); and chief engineer and city manager of Watertown, N.Y. (1920–1930). At the time of his retirement in 1940, he was chief engineer of the Utica Board of Water Supply.

William Manning Bassett (M. '49), age 74, consulting engineer of West Newton, Mass., died there on December 22. In 1948 Mr. Bassett retired as structural engineer for the New England Power Service Company of Boston after 35 years of service. A graduate of Massachusetts Institute of Technology, class of 1902, Mr. Bassett was for thirteen years designer and assistant engineer for the New York Central Railroad, New York City. During this period he was instrumental in the design of skyscrapers in the Grand Central Terminal Improvements Program.

Leon John Bezkor (A.M. '49), age 49, assistant civil engineer, Board of Water Supply, New York City, died recently. Mr. Bezkor was educated at the City College of New York School of Technology and began work with the Board of Water Supply in 1931. Following employment in various fields from 1934 to 1937, he rejoined the Board of Water Supply and was connected with construction of the Delaware Aqueduct.

Leon J. Bezkor

Fred F. Gordon (M. '14), age 85, retired civil engineer of Rochester, N.Y., died Dec. 20. Mr. Gordon was with Eastman Kodak Co., Kodak Park Works, Rochester, N.Y., for 22 years until his retirement in 1938. He supervised construction of large industrial buildings, and a water works system and developed housing projects and railroad facilities at Kodak Park. After retiring he practiced as a civil and sanitary engineer in Rochester, N.Y. Mr. Gordon was the author of a work on treatment of cannery waste.

Edwin Ambler Ingham (M. '28), age 68, City Manager of Alhambra, Calif., died suddenly on November 28, after returning from a vacation. Mr. Ingham had been city manager of Alhambra for the past ten years and previously in the same capacity at Glendale and Coronado for eight years each. A graduate of the

(*Continued on page 90*)

Concrete Paving Record Set in Widening Garden State Parkway

Only seven weeks were needed to widen the 13½ mile toll-free concrete section of New Jersey's Garden State Parkway from four to six lanes. A third 12-ft. lane in each roadway was placed at an average of 5,080 lin. ft. per day. The 24-hour record of 7,980 ft. with one finishing train is believed to be a world record.

The achievement is especially remarkable because traffic on the busy expressway was not detoured. In addition to placing 177,133 sq.yd. of concrete, the contractor ripped up existing shoulders, completed necessary grading, installed drainage, excavated 75,000 cu.yd. of roadway and placed 50,000 cu.yd. of granular subbase.

This performance demonstrates conclusively that high-quality concrete pavement can be placed as fast, or faster, as less durable material.

Widening existing roads or paving new ones with concrete offers many advantages in addition to rapid placement. Concrete usually costs less to build than other pavements *when both are designed for the same traffic.* Concrete lasts at least twice as long and needs much less maintenance. Only concrete gives true ***low-annual-cost*** service. Moreover, concrete pavement is much safer. It is skid-resistant, wet or dry, and its light color provides better visibility and greater safety at night, when the accident rate is highest.

Write for free information about widening or resurfacing pavements with concrete. Literature distribution is limited to the U.S. and Canada.

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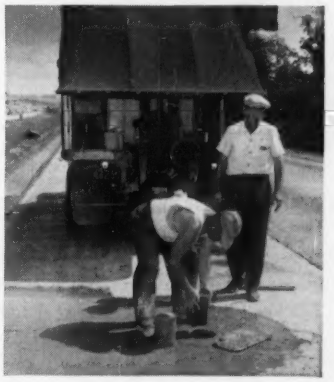

Top photo shows finished third lane in each roadway before being opened to traffic. Right: Core being removed from a new slab tested 4,900 p.s.i. When original lanes were built in 1950 core from adjacent slab tested 5,000 p.s.i. New core from the same slab recently tested 6,100 p.s.i., proving that concrete pavements grow stronger with age.

SAXTON MOVES 560-TON DRAGLINE 7 MILES IN 7 DAYS

Thousands of dollars and hundreds of hours saved by use of two CAT* Mobile Electric Sets, powering it on a rugged trek across highways, railroads, utility lines, swampy bottom land and a 50-foot river!

Power to move this 560-ton dragline seven miles cross country was supplied by two Cat D397 Mobile Electric Sets. The journey continued round the clock, ceasing at night only when roads, railroads or power lines were met.

With its strip mine in Somerville, Indiana, exhausted, the Saxton Coal Company decided to move to a new area near Oakland City, seven miles away. This posed many problems. One of the biggest was how to transfer its 560-ton Marion electric 7400 walking dragline.

Three methods were available: (1) Disassembling the unit and then reassembling it at the new area. This would cost about $60,000 and take three months. (2) Using utility power, which meant erecting lines, taking them down and erecting them again. This would cost about $45,000 and take thirty days. (3) Using mobile power. This would cost about $30,000 and take less time.

Saxton officials decided upon the third method. For power, they chose two Caterpillar* D397 Portable Electric Sets with a combined output of 630 KW. Then they negotiated for passage across private property, power lines, railroads and highways.

Preparing to lift a power line pole out of the way. A total of five power lines had to be crossed.

Crossing bottom land, a D7 clears off the top layer of sod to prevent balling of sod in front of the dragline tub. Usually a 100-foot swath was 'dozed for passage.

Crossing State Highway No. 64, a D7 helps the dragline prepare a protective bed of earth five feet deep. Dragline in rear, along with another D7, does necessary restoration to terrain.

Cat D397 Mobile Electric Set moving up. Dragline traveled 2000 ft. between electric set moves.

Along with the two D397s, Saxton used two Cat D7 Tractors with Bulldozers and a Bucyrus Erie 15B dragline. Depending on the need, the 'dozers cleared land ahead of the 560-ton giant, replaced damaged terrain and handled other earthmoving chores. Great care was taken all along the route to leave the areas crossed in good condition.

Two power cables, each 1000 feet long, were used to walk the dragline. This allowed the unit to travel 2000 feet before the Cat Mobile Electric Sets had to unhook and move. They were reset 1000 feet beyond the dragline. The dragline averaged 400 feet an hour in good going.

Whenever possible, the dragline traveled around the clock, except in crossing highways, railroads or power lines. In all, a total of seven roads, five power lines and three railroads were crossed, plus pipe lines, water lines and a river.

Crossing the South Fork of the Patoka river, about 50 feet wide and 12 feet deep, presented the greatest risk. Although the flow is not swift, there is the threat of torrents from heavy rains.

Instead of laying tubes in the river bottom, a diversion canal was built. To allow the dragline to cross, about 3000 cubic yards of dirt were dug by the dragline itself and compacted by the 'dozers. After crossing, the dragline cleared the channel. Meanwhile, the rugged D7s were clearing land ahead.

Good weather held during the journey, which required seven working days. Considering the length of the route and the hazards met, the operation progressed well. Said Bernard Youngs, vice president of Saxton Coal Company, Petersburg, "Mobile power is the way to move one of these machines."

Throughout the rugged trek, the Caterpillar units delivered the typical reliable performance expected of them. With electric sets up to 315 KW, there's a range of power suitable for all types of jobs. All Cat Electric Sets are backed by prompt service from the Caterpillar Dealer, who will be glad to furnish complete details about them.

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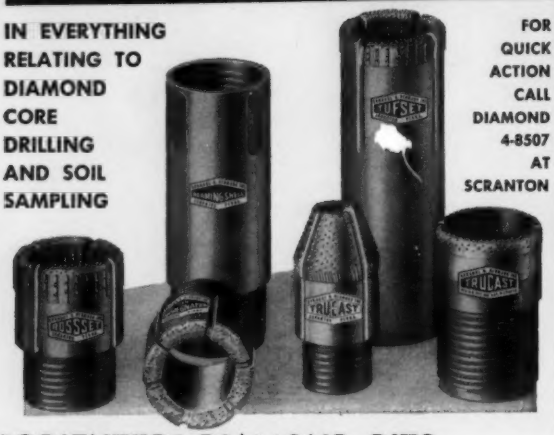

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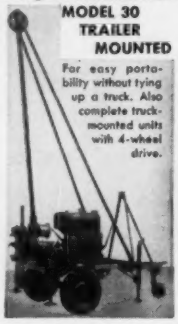

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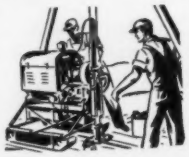

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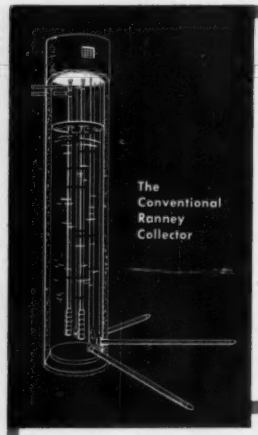

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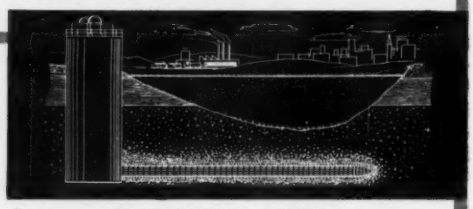

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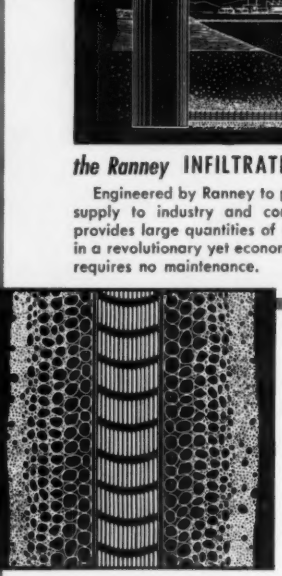

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14-Story Medical Building Has High-Strength Bolting

In this typical installation picture, the nut is being drawn up on the Bethlehem High-Strength Bolt by means of a pneumatic impact wrench, as a holding wrench grasps the bolt head firmly.

This attractive new structure is the University of Oregon Medical School, in Portland. The 14-story building accommodates 277 patients and has extensive facilities for medical research. The steel members making up its 1170-ton frame were joined by Bethlehem High-Strength Bolts rather than by riveting.

Because of the saving in erection time they make possible, Bethlehem High-Strength Bolts are ideal for connecting structural steel members. They save time because they can be installed quickly by means of a calibrated pneumatic impact wrench. And not only does the wrench draw up the nut rapidly, it also applies sufficient torque to provide permanently tight joints.

Relative freedom from noise is another advantage of high-strength bolting, making it particularly desirable in areas where undue noise would be objectionable. For a pneumatic impact wrench is less noisy than a riveting gun.

Bethlehem High-Strength Bolts are made of strong carbon steel. They are heat-treated by quenching and tempering, and can be relied on to fully meet the requirements of ASTM Specification A-325.

If you would like to have more information about high-strength bolting, we suggest you call in one of our engineers. Just get in touch with the nearest Bethlehem office, or drop a line to us at Bethlehem, Pa.

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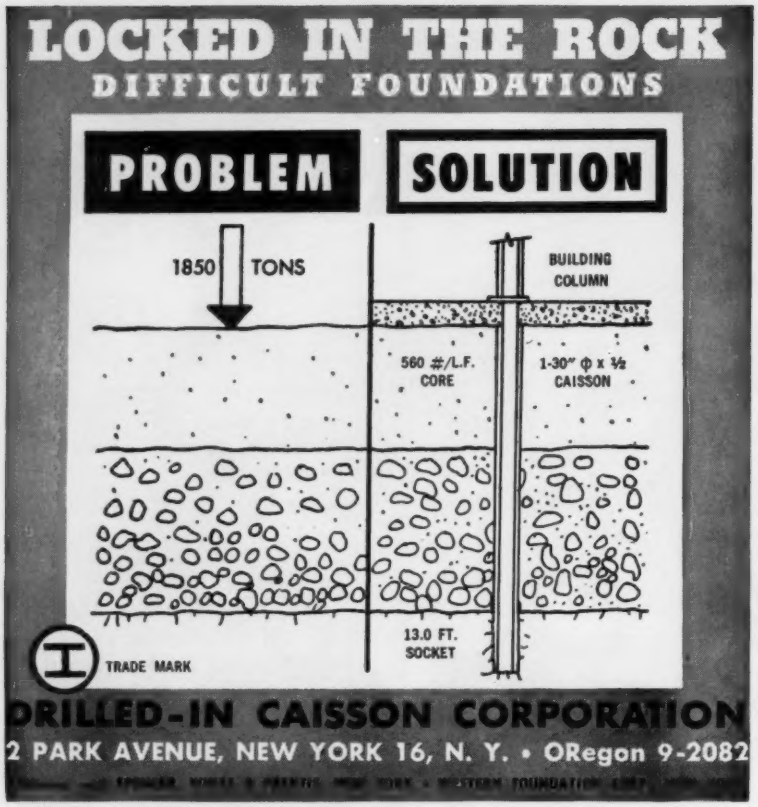

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Deceased

(*Continued from page 84*)

University of California, class of 1912, Mr. Ingham was associated with C. C. Kennedy in San Francisco as municipal and sanitary engineer doing special work on dams and valuation.

Hollister Johnson (A.M. '17), age 64, of Watertown, N.Y., retired hydraulic engineer, U. S. Geological Survey, died November 1. A 1912 graduate of Cornell University, Mr. Johnson served overseas in World War I as captain in the Corps of Engineers. In 1933, following appointments in the New York State Conservation Commission and the Black River Regulating District, Mr. Johnson joined the Geological Survey. He became a specialist in the development of techniques and methods for the determination of peak discharges by indirect methods and directed the preparation of studies and reports on major floods throughout the United States. He retired in 1952.

Valens Jones (M. '49), age 51, civil engineer of Denver Colo., died there on January 2. A graduate of Montana State College, class of 1927, Mr. Jones had been connected with the Bureau of Reclamation since 1927 at Augusta, Mont. and then at the Bureau's central laboratories in Denver. He took part in the pioneering laboratory investigations preceding construction of Hoover, Grand Coulee, Shasta, and other dams. He was noted for his work in developing procedures and equipment for testing concrete for dams and related structures. He was also head of the laboratories' Structural and Foundations Section at Denver when he left in December 1954 to join the Commercial Testing Laboratories in Denver.

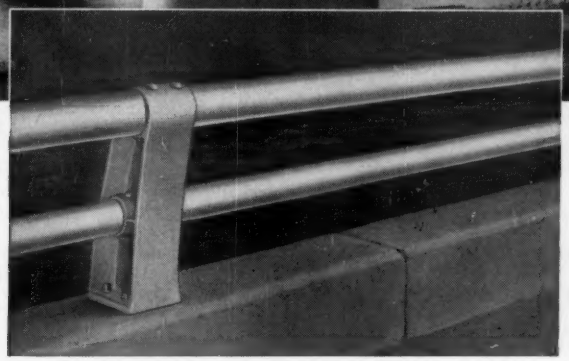
Valens Jones

Clark Morton Kee (A.M. '28), age 61, former construction engineer with the Hawaii Aeronautics Commission at Honolulu Airport, died at Hayword, Calif., on December 13. Mr. Kee served with the Corp of Engineers from 1922 to 1927 on construction of the Hilo Breakwater in Hawaii. For the past 26 years he held various positions in the airlines field, including section superintendent for Pan American Airways, vice-president of All American Airways, and airway engineer for American Airlines.

Edmund Randolph Kent (A.M. '28) age 64, of Tucson Ariz., died there on October 20. A 1918 graduate of the University of California, Mr. Kent also studied at Massachusetts Institute of Technology. During World War I he served in France with the 33rd Engineers, A.E.F., and subsequently was an American Exchange

(*Continued on page 92*)

Sweeping Proof of Aluminum's Superiority for low-cost, rustproof BRIDGE RAILINGS!



Reynolds Aluminum Guard Rails on Paseo Trafficway between North Kansas City and Kansas City, Missouri.

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Once again a standard Reynolds Aluminum mill product—extruded pipe—was specified for its ease of installation and all around functional superiority, its adaptability to a specific design need. For other requirements and for names of metal fabricators who can perform aluminum work to your specifications, call the nearest Reynolds Office listed under "Aluminum" in classified directories. Or write to **Reynolds Metals Company,** General Sales Office, Louisville 1, Kentucky.

For quick reference, see catalog $\frac{5a}{Re}$ *in Sweet's Architectural File.*

REYNOLDS ALUMINUM

See "FRONTIER," Reynolds great dramatic series, Sundays, NBC-TV Network.

Deceased

(*Continued from page 90*)

Student at Cambridge University, England. As a consulting civil engineer, Mr. Kent served the government and private concerns on various projects particularly bridges, water works, and dams in California and New Mexico.

Frank Norman Kneas (M. '23), age 80, prominent structural engineer, architect and inventor of Philadelphia, Pa., died there on December 26. He designed hundreds of important buildings in Philadelphia and other parts of the state including the Franklin Institute. A graduate of Lehigh University in 1898, his first employment was with the Cambria Steel Co., Johnstown, Pa. In 1916 he became chief engineer in the architectural firm of the late John T. Windrom of Philadelphia until the death of Mr. Windrom in 1934. He opened his own office as a consulting engineer in Philadelphia in 1936 after serving in Washington for two years designing projects for the Federal Government. Mr. Kneas originated many engineering devices including the cantilever system for the framing of steel and the drop penetration rod.

Saul Landman (J.M. '42), age 35, civil engineer in the Maps and Surveys Div. of Tennessee Valley Authority, Chattanooga, Tenn., died suddenly on November 24, while on vacation in Boston, Mass. A graduate of Northeastern University, class of 1942, Mr. Landman was associated with TVA for thirteen years. He served in the Army Corps of Engineers during the war.

Harry Lloyd Nelson (A.M. '30), age 52, for 31 years a member of the United States Pipe and Foundry Co., Birmingham, Ala., died December 28. He served in various capacities in the sales department and at the time of his death was director of Market Research, promotion and product scheduling. Mr. Nelson was a graduate civil engineer of the University of Pennsylvania. He served with the Utilities Branch of the War Production Board during the war. Prominent in the American Water Works Association as an officer for three sections, Mr. Nelson was recipient of the Fuller Award.

Fremont W. Slattery (M. '27), age 64, chief of the Drainage Engineering Branch for the Bureau of Reclamation at Denver, Colo., since 1951, died December 24. A 1914 graduate of Highland Park College, Mr. Slattery began work with the Bureau on its Boise Project in Idaho in 1915, followed by assignment to the Rio Grande Project in Texas. Following his employment from 1922 to 1933 with private irrigation districts and as superintendent of the William R. Hearst Activities in San Simeon, Calif., he served with the Department of Agriculture, the Indian Irrigation Service, and the War Relocation Authority. He rejoined the Bureau in 1944, transferring to the Bureau's central engineering office at Denver in 1948. He worked on the Deschutes Project in Oregon before his transfer.

Fremont W. Slattery

Clarence A. Snider (M. '23), age 85, president of the Sulphur Export Company of New York City from 1936 until his retirement in 1952, died recently at his home in New Rochelle, N.Y. He was a graduate of Cornell University, class of 1891. Early in his career Mr. Snider was superintendent and works manager of the French Process Soda Co. of Cleveland, Ohio, and secretary-manager and later owner of Snider-Hughes Company of Cleveland. He had also been associated for thirteen years with the Union Sulphur Company of New York City as assistant manager, secretary and treasurer.

Henry Bell Steeg (M. '43), age 55, construction engineer and former city engineer of Indianapolis, Ind., died there on December 17. A graduate of Purdue University, class of 1924, Mr. Steeg was connected with the Indianapolis City Planning Commission in various capaci-

(*Continued on page 94*)

Fairchild Aerial Surveys help Morrison-Knudsen plan huge development in Afghanistan

A typical example of how Fairchild aerial survey techniques are put to use throughout the world

The $78,000,000 development program now being carried forward in Afghanistan by Morrison-Knudsen is a dramatic experiment in nation building.

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Fairchild was chosen by Morrison-Knudsen to execute all aerial photography and topographic mapping for this impressive program.

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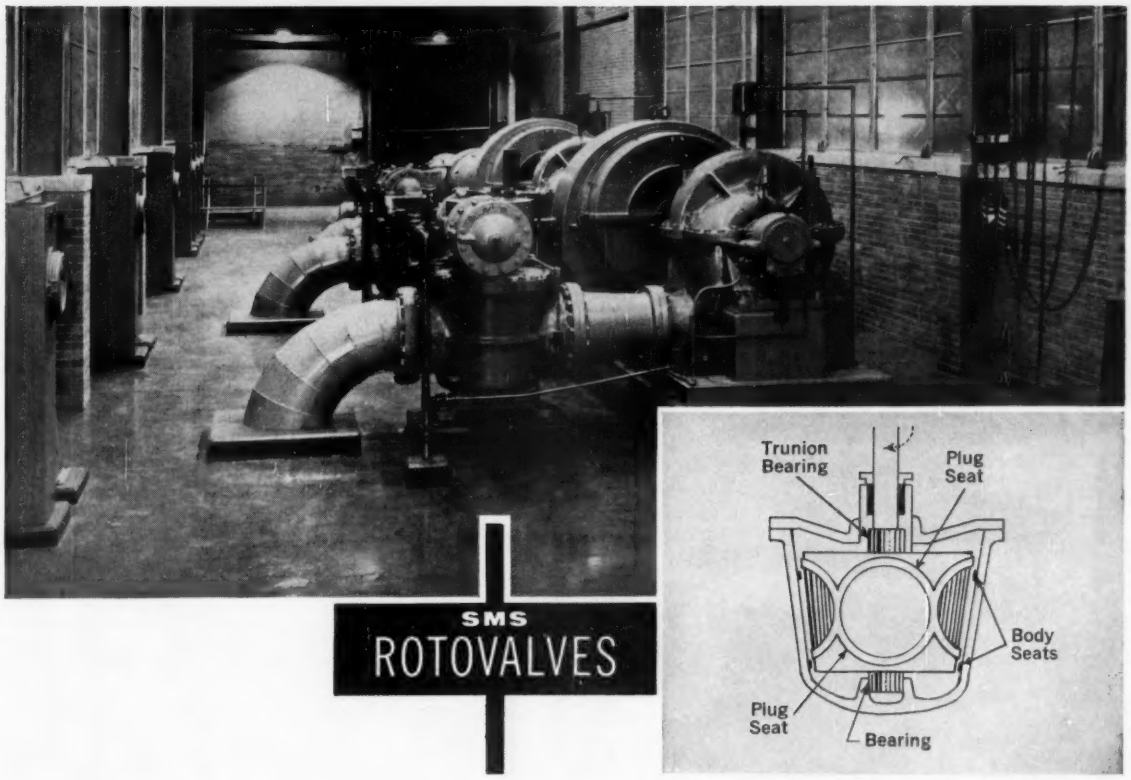

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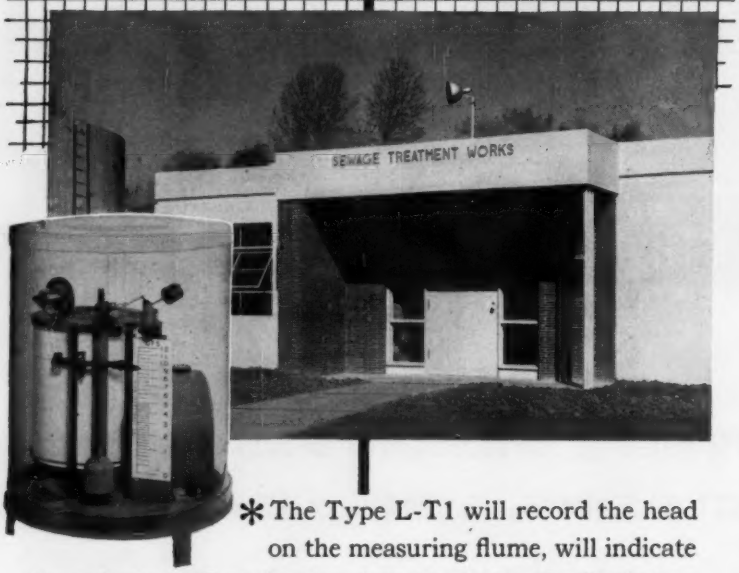

* The Type L-T1 will record the head on the measuring flume, will indicate the volume of flow for any time interval and will give an instantaneous reading of the rate of flow. The head record, made on convenient rectangular coordinates, is basic information for permanent record from which plant operators and State Sanitary Engineers can check flows and volumes. The volume reading from the totalizer dials and the rate of flow indicator are essential for intelligent operation. Readings can be made in any desired volume and flow units.

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(*Continued from page 92*)

ties for thirteen years. From 1935 to 1938 he was city engineer. Since 1941 he had been president of the engineering firm of Henry B. Steeg & Associates in Indianapolis.

Donald Wood Taylor (A.M. '35), age 55, associate professor of soil mechanics at Massachusetts Institute of Technology, died at his home in Arlington, Mass., on December 24. Professor Taylor was a graduate of Worcester Polytechnic Institute, class of 1922. On the M.I.T. civil engineering faculty for the past twenty-three years, he had been research assistant and research associate in civil engineering; assistant professor of soil mechanics; and (since 1944) associate professor of soil mechanics.

Herman Tiedge, Jr. (J.M. '50), age 30, sales engineer of Associated Engineers Inc., Boston, Mass., died there on November 23. A graduate of Rhode Island State College, class of 1950, Mr. Tiedge was connected with the Bureau of Reclamation on construction of Grand Coulee Dam, Washington for a period of time.

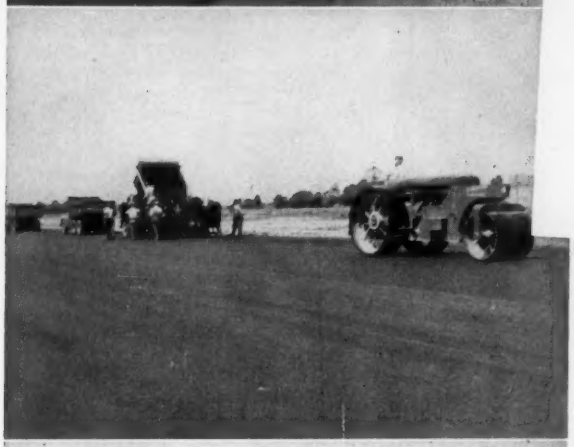
Garrett Edward Tilt (M. '13), age 78, retired consulting engineer of Fairlawn, N.J., died there recently. Mr. Tilt was associated with Brown & Matthews, New York, N.Y., before his retirement in 1950, and for many years had his own practice in the name of G. E. Tilt & Co. and, later, the Tilt-Hargan Co. He had also been chief engineer of John Monks & Sons of New York.

Francis Westervelt Tooker (A.M. '05) age 80, of East Orange, N.J., retired officer engineer for the Northern Construction Division of the New Jersey State Highway Dept., died there recently. A graduate of New York University, class of 1908, Mr. Tooker was associated with Charles W. Leavitt, Jr., in the design and construction of sewers and sewerage disposal works for Bronxville, N.Y. He joined the New Jersey State Highway Dept. in 1915, holding the titles of resident and principal engineer and officer engineer. He retired October 1954.

George Curtis Wallace (M. '48), age 49, civil engineer with Metcalf & Eddy, engineering consultants of Boston, Mass., died November 27 in Madrid, Spain, where he was working on the construction of U. S. bases. From 1947 until recently Mr. Wallace was engineer in charge of the Division of Sewers, City and County of Honolulu. Earlier he had been project engineer for Austin & Towill, of Honolulu, in charge of the design of sewage facilities.

G. C. Wallace

(*Continued on page 96*)



Constructing hot-mix, heavy-duty Texaco Asphaltic Concrete pavement on runway of Hulman Municipal Airport, Terre Haute, Ind., new home of the jet-driven planes of Indiana's Air National Guard.

CONTRACTORS

Shumaker Bros. Industries, Inc., Indianapolis
Grady Asphalt, Inc., Indianapolis

What type pavement for Airports?

Hulman Municipal Airport at Terre Haute, Ind., new home of that State's Air National Guard, recently completed some major improvements. The old 5,300-foot east-west runway was extended to 7,900 feet and a new 7,000 foot taxiway was added.

The same resilient, all-flexible type of construction was used for both runway and taxiway. A hot-mix Texaco Asphaltic Concrete surface, three inches thick, was laid over a 9-inch water-bound macadam base and a 9-inch stabilized gravel sub-base.

The ability of this type of airport construction to absorb impact and to maintain complete, lasting contact with the supporting sub-soil explains its exceptional durability and low upkeep cost. Its first cost, too, represents a worthwhile saving over other pavements having the same load-carrying capacity. Freedom from joints and immunity to ice control chemicals are other desirable features of Terre Haute's Texaco-paved runway and taxiway.

Highway and airport builders will find helpful information on all types of asphalt construction in two free Texaco booklets which can be obtained without obligation by writing our nearest office.

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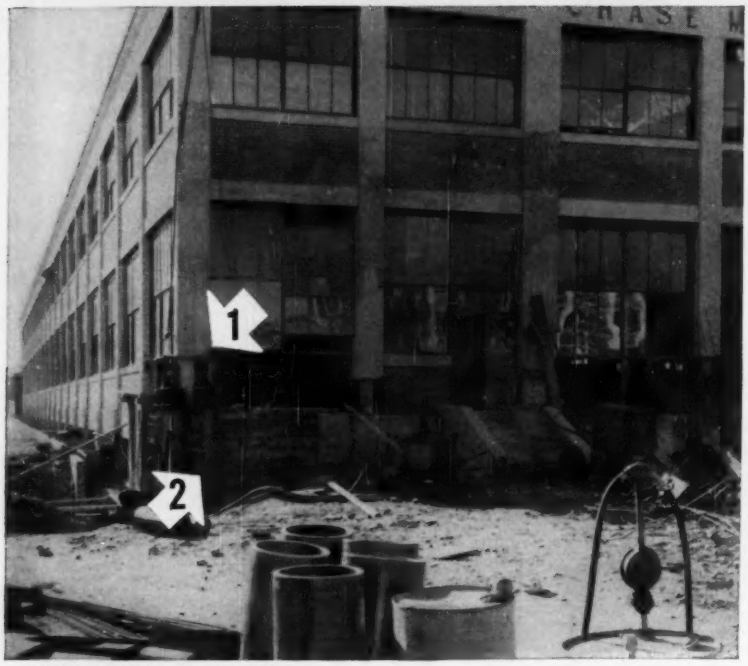
FLOOD UNDERMINES FOUNDATION —AID RUSHED WITHIN HOURS



1. DANGER OF COLLAPSE AT THIS CORNER
2. TEMPORARY SHORES

Project: Shoring and Underpinning Machine Shop, Chase Brass Co. Plant, Waterville, Conn.
Engineers: Lockwood Greene Engineers, Inc. New York City

The rampaging waters of Connecticut's Naugatuck River, swollen by Hurricane Diane, had ripped a 25-ft. hole in the Northeast corner of this Chase Brass plant. Collapse threatened.

Emergencies are no novelty to Spencer, White & Prentis—we've handled many of them in our 36 years. In this instance, the rush-call reached us Friday. By Saturday morning remedial work was under way, continuing through the weekend until the structure was made safe.

Maintaining complete facilities and permanent personnel, Spencer, White & Prentis is ready-for-action at all times.

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Deceased

(*Continued from page 94*)

During the war Mr. Wallace was with the Fifth Naval Construction Brigade in charge of planning and design of naval installations in Hawaii, Guam and Saipan. He was a graduate of Cornell University, class of 1931.

Milton Whitson (M. '19), age 77, retired structural engineer of Englewood, N.J., died there December 15. He was a graduate of the University of Illinois in 1902. Mr. Whitson was superintendent of construction for Stone & Webster Engineering Corp., from 1903 to 1912, from 1919 to 1926, and from 1931 to 1934, serving as manager of its Seattle office, as Pacific Coast manager in San Francisco, and as vice-president of construction. In the interim he was with Grant Smith & Co. as a partner and saw wartime service in the army as a colonel in the Quartermaster Corps in charge of its construction division. He had also been assistant chairman of Ulen & Co., engaged in construction work in South America and Europe, and later was a partner in Mason, Walsh, Atkinson & Kier, contractors on construction of Grand Coulee Dam.

Positions Announced

Government of Guam. The Department of Public Works, Government of Guam, announces openings for persons with civil engineering training and experience in the design, construction, and maintenance of buildings, roads, and water lines. Openings are for Engineer III (salary $7,150–$8,970) and Engineer IV (salary $7,800–$9,750–$12,350) to head up the work of the Department. A two-year contract is offered, and transportation for the employee and his family from point of recruitment to Guam and return is at the expense of the Government of Guam. Furnished housing is also provided at nominal rental. Inquiries should be sent to Peter C. Siguenza, Director of Personnel, Government of Guam, Agana, Guam.

Philadelphia Department of Public Health. There are Civil Service openings in Philadelphia for Public Health Engineer I (salary $4,500–$5,160). Minimum requirements, graduation with a degree in sanitary, civil, chemical or mechanical engineering. Location, Philadelphia. Public Health Engineer II for air pollution control work (salary $5,160–$6,192). Must have a degree in sanitary, civil, chemical or mechanical engineering, plus two years experience in public health engineering, industrial hygiene, or air pollution control or combustion engineering. For further information write to the Personnel Department of the City of Philadelphia, Room 127 City Hall, Philadelphia 7, Pa.

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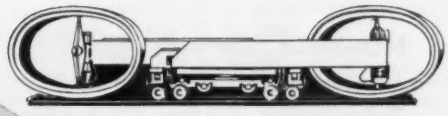
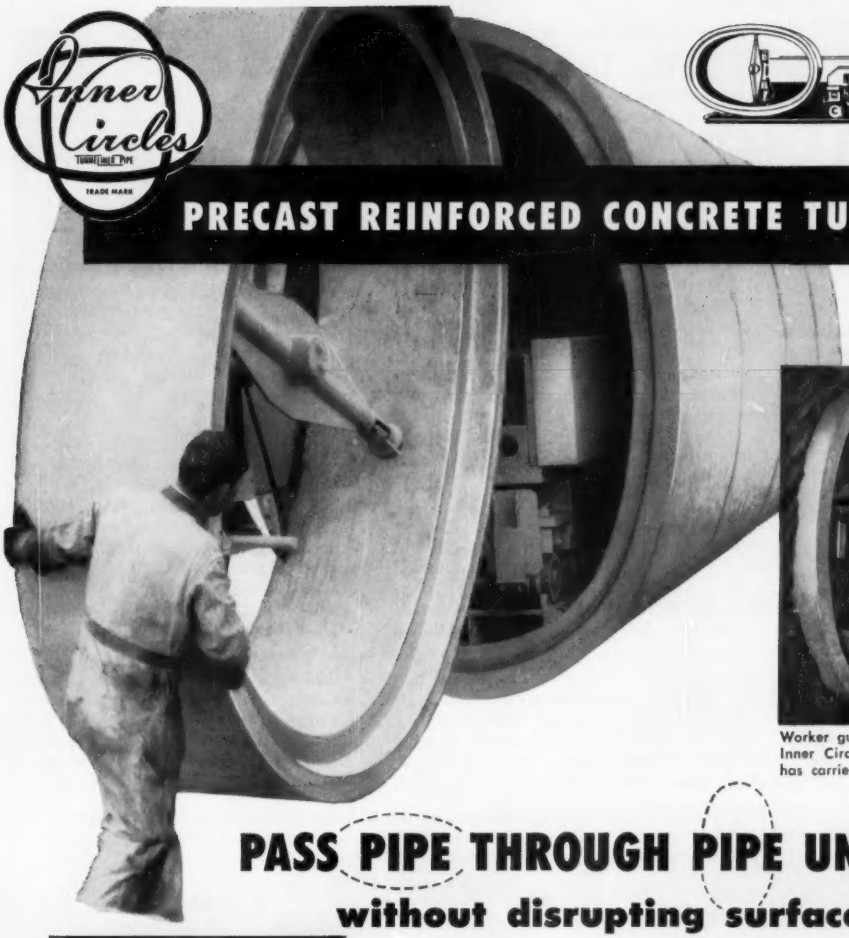
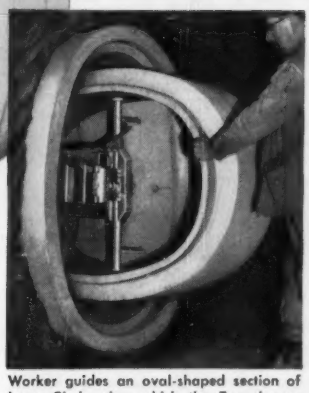
TRADE MARK



PRECAST REINFORCED CONCRETE TUNNEL PIPE





Worker guides an oval-shaped section of Inner Circle pipe which the Tunnelugger has carried through conduit already laid.

PASS PIPE THROUGH PIPE UNDERGROUND

without disrupting surface traffic!

The Tunnelugger backs off with the pipe still on the arms to set it firmly in place, assuring an even, tight joint.

Inner Circles methods using elliptical Tunneliner pipe now make it possible to pass full structural ring, precast, concrete pipe through conduit already laid—even on curves. Surface excavation is eliminated...traffic is undisturbed...work progresses regardless of weather conditions. Less equipment and fewer laborers are required, yet sewers are completed faster at less cost, with pipe strengths *pretested* by commercial laboratory procedures.

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Non-ASCE Meetings

American Concrete Institute. Fifty-second annual convention at the Bellevue-Stratford Hotel, Philadelphia, Pa., February 20–23. Further information from ACI, 18263 W. McNichols Road, Detroit 19, Mich.

American Concrete Pipe Association. Forty-eighth annual meeting, Broadmoor Hotel, Colorado Springs, Colo., March 6–10. Howard F. Peckworth, managing director, ACPA, 228 N. LaSalle Street, Chicago 1, Ill.

American Congress on Surveying and Mapping. Sixteenth annual meeting, Shoreham Hotel, Washington, D.C., March 18–21. For information on meetings contact Franklin G. Williams, chairman, ACSM, 5514 Nevada Avenue, N. W., Washington, D.C.

American Institute of Chemical Engineers. Thirty-third national meeting, the Statler Hotel, Los Angeles, Calif., February 26–29. Information, Secretary, AIChE, 25 West 45 Street, New York 36, N.Y.

American Institute of Industrial Engineers, Inc. Fifth Annual Spring Conference, March 15–16, Cleveland Chapter. For information write to W. S. Ritchie, A.I.I.E., Room No. 330, Cuyahoga Savings Bldg., 2123 E. 9th Street, Cleveland 15, Ohio.

American Institute of Mining and Metallurgical Engineers. Annual meeting at the Statler Hotel and New Yorker Hotel, New York, February 20–23. Annual dinner at the Waldorf-Astoria, February 22. Information from AIME, 29 West 39th Street, N.Y. 18, N.Y.

American Society of Photogrammetry. Twenty-second annual meeting, Shoreham Hotel, Washington, D.C., March 21–24, Information from William A. Radlinski, chairman, ASP, 1719 Keokee Street, Hyattsville, Md.

American Society For Testing Materials. 1956 committee week and spring meeting, Hotel Statler, Buffalo, N.Y., February 27–March 2. Information from Fred F. Van Atta, Assistant Secretary, 1916 Race Street, Philadelphia, Pa.

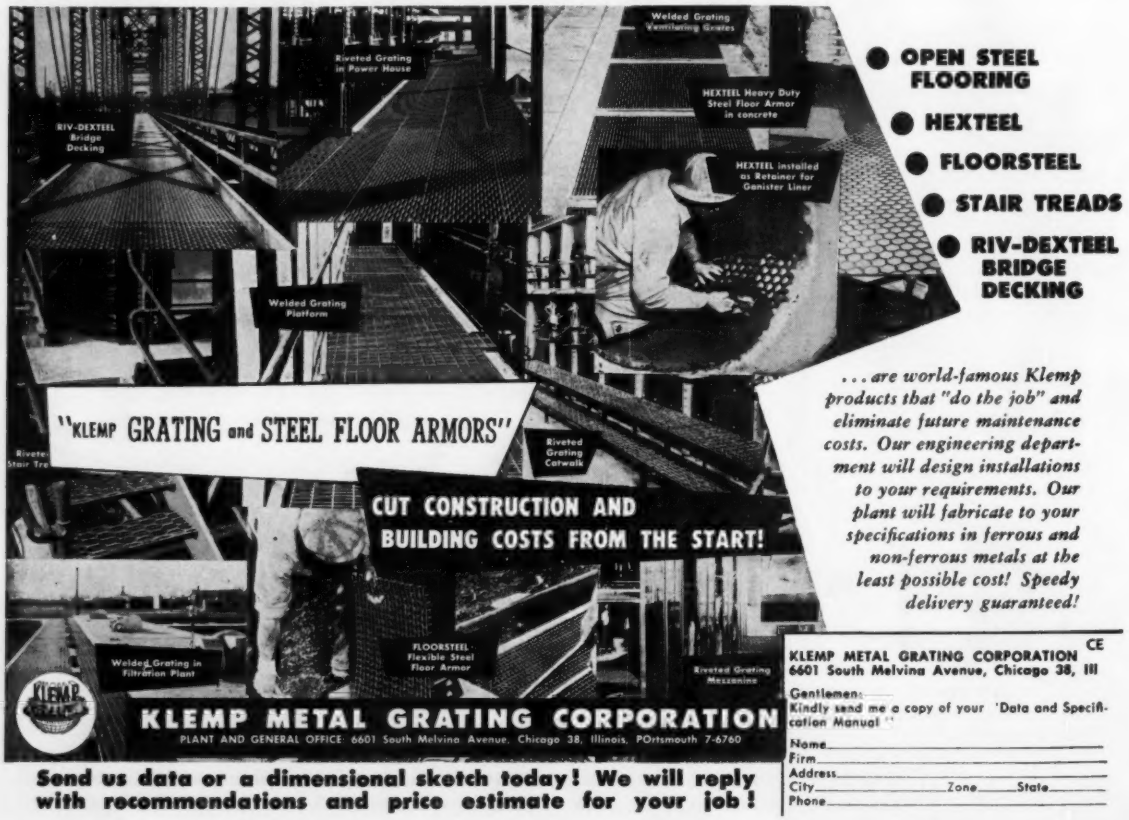
National Association of Corrosion Engineers. Twelfth annual Corrosion Conference will be held concurrently with the 1956 Corrosion Show, March 12–16, at the Hotel Statler, New York City. For information, A. B. Campbell, Executive Secretary, NACE, 1061 M & M Bldg., Houston 2, Texas.

National Society of Professional Engineers. Annual spring meeting, Mayflower Hotel, Washington, D.C., February 17–18. Information, Kenneth E. Trombley, NSPE, 1121 15th Street, N. W., Washington 5, D.C.

University of Colorado. Twenty-ninth annual Highway Engineering Conference, Boulder, Colo., February 23–24. For information, Roderick L. Downing, Conference Chairman, Department of Civil Engineering, University of Colorado, Boulder, Colo.

University of Illinois, College of Engineering. Forth-second annual Illinois Highway Engineering Conference, Urbana, Ill., February 28–March 1. Assistant Director, John W. Hutchinson, 303 Civil Engineering Hall, Urbana, Ill. Eighth annual Illinois Traffic Engineering Conference, Urbana, Ill., March 2. Director, John E. Baerwald, 401 Civil Engineering Hall, Urbana, Ill.

University of Mississippi. Second annual Mississippi Highway Conference, University, Miss., February 23–24. For information write to D. C. Trexler, Director, Department of Conferences and Institutes, University, Miss.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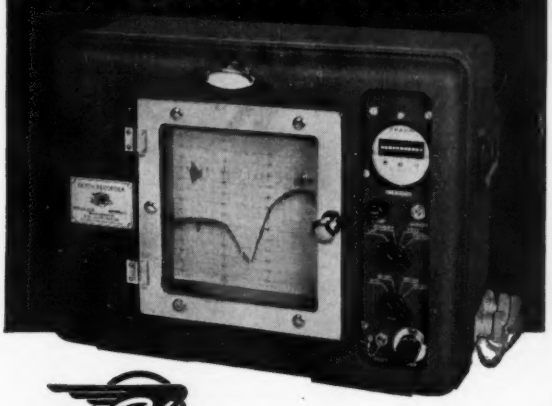

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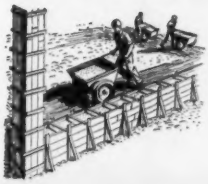

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Problems and Control of Air Pollution

Proceedings of the First International Congress on Air Pollution

These proceedings papers, presented by experts from seven countries, provide new and authoritative information on a wide range of subjects of interest to engineers, municipal officials, management, and others concerned with reducing or eliminating air contamination. Two papers review the British smog problem; the remaining twenty-three cover specific topics relating to gaps in available knowledge, current research findings, the treatment and recovery of sulfur dioxide, and experiences abroad. Edited by Frederick S. Malletta. (Reinhold Publishing Corp., 430 Park Ave., New York 22, 1955. 272 pp., $7.50.)

Professional Development—the Responsibility of Industry and the Engineer

Conference Proceedings

These proceedings of the National Society of Professional Engineers contain five papers dealing with industry's responsibilities to the engineer, the development and utilization of engineers in industry, the need for engineer-industry cooperation, the engineer's responsibility to industry, and the role of engineering education in engineer-industry cooperation. (National Society of Professional Engineers, 1121 Fifteenth St., N.W., Washington 5, D.C., 1955, $4.)

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Beginning with chapters on fundamental theory and materials, this extensively illustrated textbook and manual covers in detail all important aspects of the use of prestressed concrete: anchoring, stressing equipment, degrees of prestressing, connections, mobility and resistance of stressed parts, principles of construction, calculation of beams, shrinkage and creep effects, analysis of "fracture safety," stability and vibration phenomena, and special applications. Fritz Leonhardt is the author. (Wilhelm Ernst u. Sohn, Berlin, 1955. 472 pp., DM 59.)

Technique Des Travaux (Vol. III)

(Constructions, Bétons, Travaux Publics)

This third and largest volume of a series on construction (by Max Jacobson) deals with (1) earthworks and earthmoving operations of all kinds and (2) tunnel work and other underground operations. The book is essentially a manual giving specific methods and equipment for several hundred major and minor jobs covering all aspects of these two fields. Some 800 sketches and diagrams provide additional detail. (Librairie Polytechnique Ch. Béranger, Paris, 1955. 771 pp. F. fr. 7300.)

The feet* here are piers used to support Harry Street Bridge, Wichita Kansas. Inland Construction Co., Contr.

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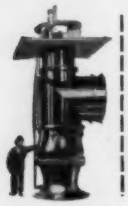
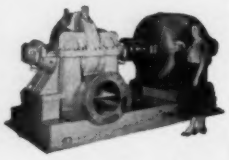


VERTICAL AXIAL FLOW FOR CIRCULATING CONDENSER COOLING WATER



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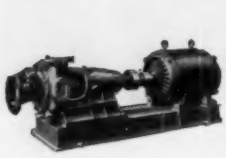
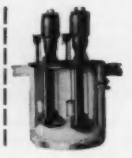


HORIZONTAL NON-CLOG FOR SEWAGE, TRASH, STOCK



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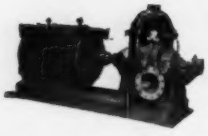

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JOHN RAYMOND CLOYD, Rocky River, Ohio.
EDWARD CLARKSON COLLINS, Pittsburgh, Pa.
JAMES ERNEST DELANEY, Frankfort, Ky.
JOHN VINCENT DINAN, New York, N. Y.
JAMES EDWARD HAMMER, Buffalo, N. Y.
LOUIS HENRY KRISTOF, Sacramento, Calif.
EDUARD KUIPER, Manitoba, Canada.
SOL LIFSITZ, Detroit, Mich.
CLAUDIO OLAVIDE LUQUE C., Guayaquil, Ecuador
JOHN HENRY PHELPS, Omaha, Nebr.
CHARLES ANDREW POHL, JR., Farmingdale, N. Y.
MELVILLE STANTON PRIEST, Auburn, Ala.
WILLIAM BARTELL PURNELL, Houston, Tex.
JULIAN BONHAM SHAND, Columbia, S. C.
KENNETH MURCHISON SULLY, Los Angeles, Calif.
ALBERT HERBERT SWIFT, Chicago, Ill.
MATTHEW JOSEPH TIMM, Michigan City, Ind.
GIUSEPPE TONEO, Milano, Italy.
HARRY WARFIELD, New York, N. Y.
MASARU YASUMI, Osaka, Japan.

Applying for Associate Member

ROBERT JAMES ARMSTRONG, New York, N. Y.
GEORGE RAYMOND BLAIER, Minneapolis, Minn.
HORST BORBEREKY, Boston, Mass.
STEWART FLEMING BROYLES, New York, N. Y.
BARTLETT LINLEY COUCH, Salt Lake City, Utah.
JULIUS ALOIS CSEPREGHY, Port-Lyautey, French Morocco.
ROBERT WILLIAM CZABAN, Baltimore, Md.
JUAN IPALARE DANGCIL, Manila, Philippines.
THOMAS DEWHURST, Kennewick, Wash.
WILLIAM GIBSON DUNN, Mountain View, Calif.
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WILLIAM HANSON FRENCH, Port Sulphur, La.
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DONALD KEITH GUDGEON, Collyer Quary, Singapore.
DAVID PHILLIPS HALE, Santa Fe, N. Mex.
WINSTON BRUCE HANSON, Jamaica, B.W.I.
ALTAF HUSSAIN, Washington, D. C.
PATTANAM KARUPPAN KANDASWAMY, Iowa City, Iowa.
SERGIO GONZALEZ KARG, Mexico, D.F., Mexico.
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SYED SALAR KIRMANI, Washington, D. C.
MARTIN KREGZDE, New York, N. Y.
RICHARD BURTON LENNEX, Toledo, Ohio.
JOACHIM FRIEDRICH LEPPMANN, Berkeley, Calif.
JOE LEE MERRITT, Pine Bluff, Ark.
GEORGE OBIMAKINDE OBEMBE, Toronto, Ont., Canada.
ROGER PAUL O'REILLY, Littleton, N. H.
GLOW BURMA PHILLIPS, JR., San Diego, Calif.
HAMPTON PRIMEAUX, Lafayette, La.
ROBIN ROWE REYNOLDS, Sacramento, Calif.
HARVEY SCOTT, Portland, Ore.
THEODORE EUGENE SILER, New York, N. Y.
ALBERT STRAZDINS, Buffalo, N. Y.
DENIS TEMPLE, Quebec, Canada.
BENJAMIN BERNARD TORCHINSKY, Saskatchewan, Canada.
BEVERLY JAY WHITLOW, Millbrae, Calif.
JOHN BRYAN WALKER, Oklahoma City, Okla.
ARVIDS ZAGARS, Chicago, Ill.

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JOSE LUIS ARIZTI GARAY, Mexico, D.F., Mexico.
JAMES RUSSELL BARNICLE, Montclair, N. J.
NORSE CROMWELL BEAR, Port Arthur, Tex.
JAMES MITCHELL BOWER, Lexington, Va.
HOWARD FREDERICK CHRISTENSEN, New York, N. Y.
FREDERICK GILBERT CRARY, III, Louisville, Ky.
ROGER DIAZ DE COSSIO, Champaign, Ill.
JAMES NELSON DUPUIS, Detroit, Mich.
DONALD BRUCE EMERY, Williamston, Mich.
CARLES A. EVERSON, Palo Alto, Calif.
JEROME FRANCIS FLADUNG, Kansas City, Mo.
RICHARD CUTHBERTSON HARLAN, New York, N. Y.
HOWARD SULLY HARRIS, Berkeley, Calif.
CHARLES HENRY HENAGER, Richland, Wash.
ROBERT SAMUEL HODDER, Richmond, Va.
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JOHN KARAGOZIAN, JR., Fort Knox, Ky.
JAMES STEWART KENNEDY, Edmonton, Alberta, Canada.
WILLIAM RALPH KINSEY, San Francisco, Calif.
WILLIAM CLYDE MEREDITH, Overland Park, Kans.
MARCO AURELIO PROVENCIO GALVAN, Mexico, D.F. Mexico.
BASIL WILLIAM REAGEL, Kansas City, Mo.
FRANK R. REYNOLDS, Modesto, Calif.
DAYA SHARAN, Kharagpur, India.
BRIAN PATRICK SHIELDS, Edmonton, Alberta, Canada.
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[Applications for Junior Membership from ASCE Student Chapters are not listed.]

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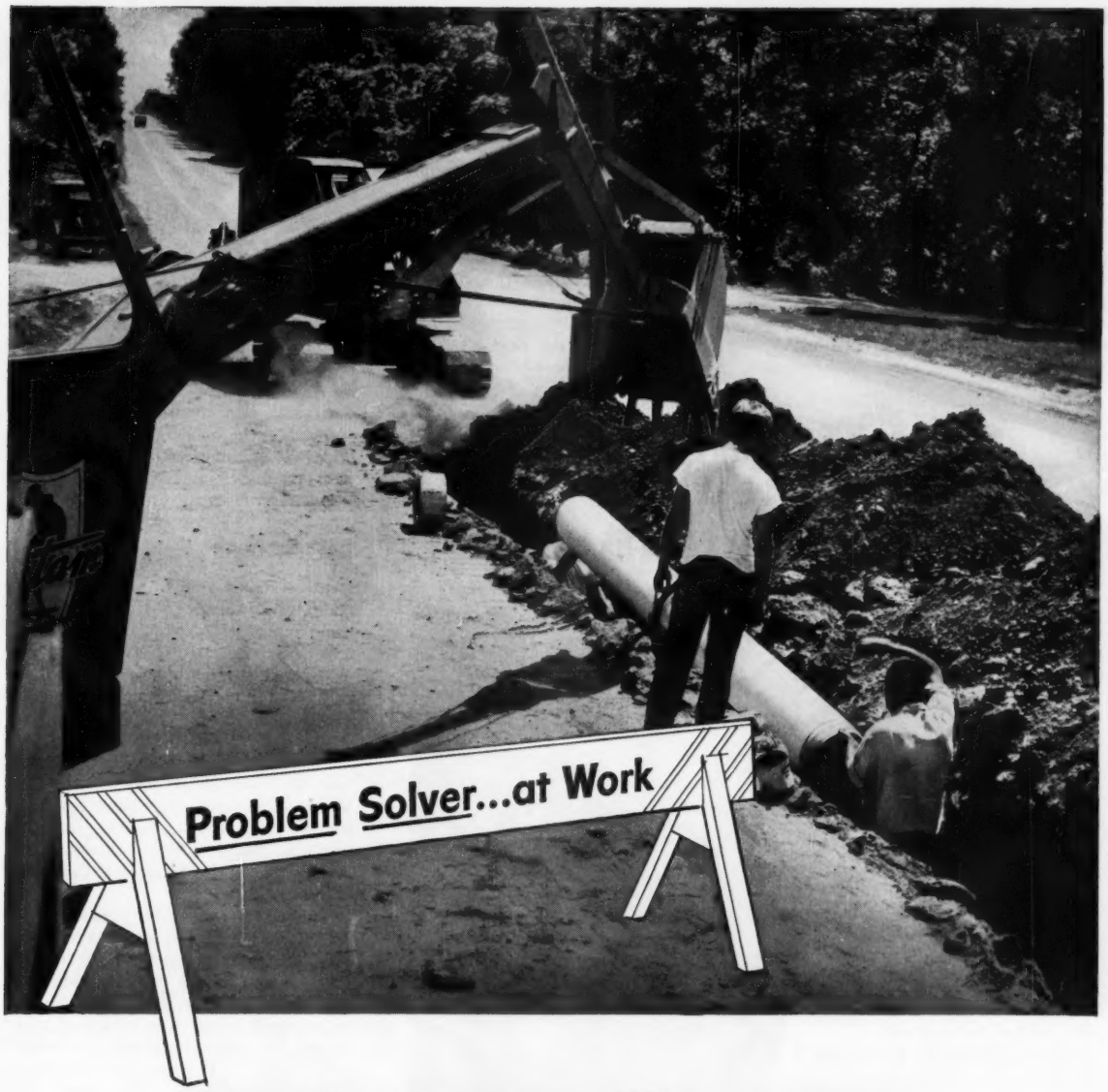

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New Orleans Bridge substructure . . .

(This article begins on page 40)

(*Continued from page 44*)

to those on the other piers will carry the structure up to El. +161.5.

A project of this nature cannot proceed satisfactorily without four important ingredients. The first of the four—and the first in order of accomplishment—is planning, which for this project was carried out by the people of New Orleans and Louisiana under the jurisdiction of the Mississippi River Bridge Authority, after many years of determined effort.

The second ingredient is design. This has been handled by Modjeski and Masters, well known for their many years of practical experience as consulting engineers on deep foundation work. They have established an enviable record, and we are pleased to be working under their direction on this project.

The third covers the men—the organization—who handle the construction work. These include the field forces of the consulting engineer under whose supervision the work is carried out, and the "on-the job" construction crew of the contractor. One of the most satisfactory relationships today is that which exists between the coordinating and "control" forces representing the customer, and the forces of the contractor who has been awarded the job on a lump-sum bid. This may be observed most effectively on this project.

Equipment—the best possible

The fourth ingredient, and probably the easiest to control, is the construction equipment used on the job. However, this is an area where the contractor's planning must be at its best, for swift water and heavy construction can be economically and speedily handled only with the proper equipment and plant. On this job the best of equipment was assembled and floated in from various other completed projects.

Since concrete is an essential element, and must be mixed and placed according to the most modern techniques, two floating mixer plants with identical batching and mixing equipment were brought to the job. Each is equipped with two 2-cu yd tilting mixers, capable of delivering 80 cu yd of concrete per hour, or a total of 160 cu yd for the two. For the larger pours, both plants will be in operation. Batching equipment on these boats is fully automatic, so that one operator at the "console" can weigh and charge the prescribed concrete ingredients and discharge the mixers into the transfer buckets. These are then handled by derrick boat or whirler crane to the point of placement.

At Pier 2, the mooring barges which initially held the stall while under construction, now serve as a floating "yard" for carrying on the work at this important pier. The two mixer boats, with cement barges, barges of sand and gravel, two heavy-duty 50-ton derrick boats with 175-ft booms, and a diesel towboat, handle the work there. At Pier 1, the shafts have been brought up to their final elevation with the help of a fully-revolving whirler crane, which has handled all the work at this pier.

The new Mississippi River Bridge at New Orleans was designed by Modjeski and Masters as consulting engineers for the Mississippi River Bridge Authority. Members of the Authority are Capt. Neville Levy, Chairman; William O. Turner, Vice-Chairman; Sen. Alvin T. Stumpf, Secretary; Richard W. Freeman, Treasurer; Robert L. Simpson; John W. Stone; W. Richard White; Frank X. Armiger, Administrator; Charles E. Cassagne, Jr., Chief Engineer; J. Raburn Monroe, General Counsel.

O. F. Sorgenfrei, M. ASCE, is resident engineer for Modjeski and Masters. Project superintendent for Dravo is B. N. Parker.

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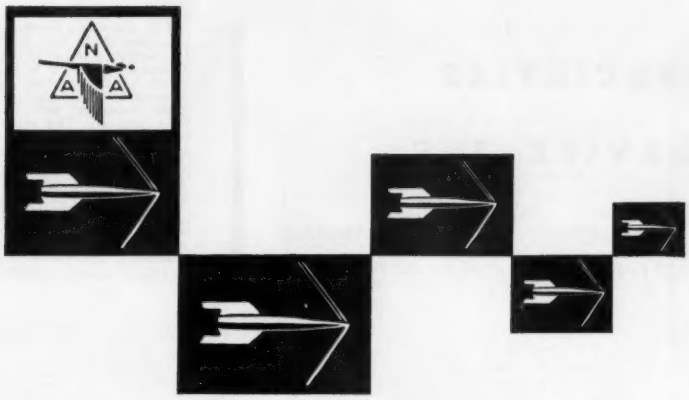

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Men Available

CHIEF STRUCTURAL ENGINEER; M. ASCE; 49; C.E. graduate, structural, plus building tradesman experience; registered California; 20 years' private and public practice. Administration, supervisory, direct and execute civil and structural design, specifications, costs drawings and contracts of foundations, indeterminate, earthquake and heavy construction for mills, shops, hydro/steam, process plants, commercial, public and waterfront. Seeks responsible position with established organization; room to advance or particpate. C-106-SF-944-San Francisco.

CIVIL ENGINEER; A.M. ASCE; 32; married; M.S. in C.E.; graduate work, 1950–1951; 10 years' experience in design and supervision of reinforced concrete and steel structures, including commercial, industrial buildings and hydraulic structures both in the U.S. and abroad. Desires position with consulting or construction firm. Will consider teaching position. Location preferred, New York or San Francisco metropolitan area. At present in the Middle East; available in April. C-107.

ASSISTANT PROFESSOR; A.M. ASCE; 43; married; 10 years' experience in teaching structures, surveying, mechanics, etc.; 10 years' experience in structural design, surveying, and construction; licensed professional engineer and land surveyor; desires position as professor, associate professor, or design engineer with consulting firm. C-108.

CIVIL ENGINEER; J.M. ASCE; B.C.E.; 26; 2 years' diversified municipal engineering knowledge and experience while working as a surveyor; 2 years' experience in aircraft technical report writing, research, etc. Desires permanent position as municipal engineer. Location preferred, New York State or Connecticut. C-109.

CITY OR TOWNSHIP ENGINEER, CONSTRUCTION ENGINEER; M. ASCE; registered professional engineer; 48; married; over 25 years' diversified experience (including 17 years with Corps of Engineers) in airfield design and construction, water supply, building construction, railroad location, construction and maintenance, road and bridge construction and maintenance. C-110.

SENIOR ADMINISTRATIVE CIVIL ENGINEER; A.M. ASCE; 25 years' wide experience in construction, maintenance, and production phases of large operations, major industrial companies with emphasis on cost control. Field practice from design survey through resident engineer heavy excavation, plant, buildings, services, town sites. Office functions include structural design; economic studies; liaison, office, cost, project engineer; drafting administration contracts. C-111.

CIVIL ENGINEER; J.M. ASCE; B.S.C.E., 1950; P.E., New York State; married; 3 years' experience in highway and bridge design and construction; 3 years' experience in municipal public works and water supply systems, small amount of building design. Desires position on construction work or as consultant in New York State or Florida. C-113.

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ASSISTANT PROFESSOR AND INSTRUCTOR IN CIVIL ENGINEERING. Assistant Professor must have special training or experience in the field of sanitary engineering. Appointees must have a broad interest, as applied mechanics and strength of materials are taught in the department as well as the civil engineering courses. Opportunity to pursue graduate studies. Position starts spring semester of 1956–57 term. Location, Midwest. W-2460-C.

ENGINEERS: (*a*) Assistant City Planner, graduate, with major work in city planning, engineering, architecture, or landscape architecture. Some experience preferred. Salary, $4,050–$4,850 a year. (*b*) City Planner, master's degree in city planning or college graduation with major work in city planning, or college graduation with major work in city planning, engineering, architecture or landscape architecture. Two years' experience in work involving planning problems. Salary, $4,450–$5,350 a year. Location, Connecticut. W-2465.

ENGINEERS: (*a*) Project Engineer, civil graduate with at least 5 years' design and field engineering experience in industrial, municipal, and hydraulic fields. Age 30–40. (*b*) Specifications Engineer and Estimator, civil or architectural graduate, with at least 5 years varied construction experience covering buildings and heavy construction. Age, 30–40. Salaries, $10,000–$10,800 a year. Duration one year. Location, Greece. F2484.

CIVIL ENGINEER, young, for general design and report writing, specializing in water design and sewerage treatment. Salary open. Location, New York, N.Y. W-2498.

SENIOR ARCHITECTURAL ENGINEER experienced in the architectural engineering field and capable of supervising draftsmen and engineers in the design of layout for industrial buildings. Should be graduate architect, and preferably registered. Salary about $9,000 a year. Location, Pennsylvania. W-2520.

JUNIOR CIVIL ENGINEER, 25–35, B.S. in C.E., with minimum of three years' design experience

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in structures, concrete, steel, etc., for an industrial plant. Will assist senior civil engineer in administration of contracts. Take off unit costs, estimating progress, checking layout, checking scheduling with construction superintendent. Salary open. Location, State of Washington. W-2535(*a*).

ASSOCIATE PROFESSOR in civil engineering, to take charge of instruction in surveying. Should be registered engineer with master's degree. Positions available now. Location, South. W-2585.

CITY ENGINEER, civil, P.E. for work involving water works, sanitation, streets and city planning. Salary, $6,000–$7,200 a year. Location, South. W-2586.

CHIEF ARCHITECT for large food organization for development of restaurant sites. Future activities of the company include manufacturing operations, motor hotels and industrial feeding operations. Salary open. Location, Washington, D.C. W-2592.

SENIOR STRUCTURAL DESIGNER, under 50, civil or mechanical graduate, with at least 10 years' supervisory experience covering steel towers, bridge and large industrial or process equipment. Company will pay fee. Salary, $10,000–$12,000 a year. Location, Ohio. W-2616-D.

ARCHITECTURAL ENGINEER for department head of industrial company on all industrial, architectural, structural, civil and sanitary engineers. Salary open. Location, western Pennsylvania. W-2624.

DESIGNER, civil graduate, with 10 to 15 years' experience in the design of airfields, roads, etc. Work will include design of pavements, grading plans, and drainage structures, etc. Salary, $8,320 a year. Location, Virginia. W-2627.

STRUCTURAL ENGINEER, qualified to design and supervise miscellaneous steel, concrete, and timber structures. Salary, $7,000 a year plus benefits. Location, Massachusetts. W-2646.

ENGINEERS. (*a*) Field Engineer, C.E. graduates, preferably with P.E. license and resident engineering experience on industrial and process construction projects to supervise layout, schedules, costs, interpretations, and revisions of plans and specifications and subcontracting. Salary, $8,400–$10,400 a year. Location, Indiana. (*b*) Office, industrial equipment experience covering design, specifications, and manufacturing of machinery for office duties and supervision of field inspection covering purchase of metallurgical and chemical process equipment. Salary, $9,000–$12,000 a year. Location, Pittsburgh, Pa. W-2652.

ESTIMATORS. (*a*) Senior Construction Estimator, under 50, engineering degree, with at least 8 years supervisory estimating experience covering heavy construction, foundations, mill buildings. Salary, $8,400–$12,000 a year. (*b*) Estimator, under 50, engineering degree, with quantity take off, pricing of materials and labor on industrial or heavy construction projects. Salary, $5,000–$8,400 a year. Location, West Coast. W-2654.

ASSISTANT SECRETARY for national engineering society. Preferably engineering graduate, but not mandatory. Duties involve coordination of all membership promotion, section formation, and sectional programs in all phases. Aptitude and genuine interest in society work a requisite. Some traveling involved, with headquarters in New York, N.Y. W-2666.

TOWN ENGINEER, graduate civil, with P.E. license, 35–45, with experience in town planning, roads, structures, etc. Salary, $6,500–$7,000 a

(*Continued on page 108*)

Information received before March 15, 1956, will appear in the 1956 Directory

FOR ASCE MEMBERSHIP DIRECTORY

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Recent Graduates with Aeronautical, Mechanical, Civil or Engineering Physics Degrees may qualify.

Proof of U. S. Citizenship Required
APPLY IN PERSON
OR SEND RESUME TO:
Engineering Personnel Dept.
INTERVIEWS AT
Employment Office
South Oyster Bay Road
North of Railroad
Monday thru Friday
8:30–11:30 AM; 1:30–3:30 PM

GRUMMAN AIRCRAFT
Engineering Corp.
Bethpage, N. Y.

Engineers and Designers

Wanted By

Southern Services, Inc.

Birmingham, Ala.

This is an opportunity to associate yourself with one of the large, progressive and firmly established engineering organizations in the Southeast, engaged in a long lasting and extensive steam and hydro expansion program for a utility system with present capacity of 3,000,000 KW, operating in Alabama, Florida, Georgia and Mississippi.

These positions are now open in Birmingham:

Senior Civil Engineers with B.S. in Civil Engineering and 10 years experience in Hydro Generation Project Design.

Designers with B.S. in Civil Engineering and experience in Structural Concrete Design.

Designers with B.S. in Mechanical or Electrical Engineering, with or without experience in Generating Station Design.

Excellent working conditions, air conditioned offices, employee benefits including insurance and retirement plan. Excellent opportunity for professional growth in the industrially active Southeast. Inspection trips to projects under construction.

Send brief resume to *Chief Design Engineer*, Southern Services, Inc., 600 No. 18th Street, Birmingham 2, Ala. State salary expected and when available.

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Offers

A Responsible Position in

FLUID FLOW

The Engineering Service Division of du Pont's Engineering Department provides other units of the company with consulting service and technical assistance in increasing capacity and yield, in reducing investment and operating costs, and in improving product quality and plant efficiency. A long-range career position is immediately available in this division to a qualified graduate engineer experienced in the specialized area of Fluid Flow.

This position will require extensive experience with very complex fluid flow problems, such as are encountered in the following types of equipment: distillation, dust collecting, filtration, grinding, drying, materials handling, absorption-extraction, and agitation and mixing. Successful applicant will develop specialized equipment such as jet reactors, jet compressors, jet absorbers, and pipe line reactors, and provide technical advice on fluid flow problems involved in handling slurries, plastics, highly viscous polymers, dispersion, and semi-solids.

Please send complete resume, including details of education and experience, to

Mr. J. C. Costello, Jr.

Engineering Department

E. I. du Pont de Nemours & Co., Inc.

Wilmington 98, Delaware

Men and Jobs Available

(*Continued from page 107*)

year. Location, Westchester County, New York. W-2669.

ASSISTANT ENGINEER, young, graduate civil, to be assistant to Town Engineer. Should have considerable knowledge of problems and proper procedures involved in making engineering surveys; taking field notes; preparation of routine construction plans and specifications; draft engineering notes and plans, etc. Salary, $8,400–$5,200 a year. Must be resident of New Jersey. Location, northern New Jersey. W-2684.

TEACHING PERSONNEL FOR DEPARTMENT OF CIVIL ENGINEERING. (*a*) Professor-Department head. Department majors in structures, both steel and concrete, and soil mechanics. Usual basic courses are offered. (*b*) Instructors to teach principally drawing, surveying, mechanics, strength of materials, materials laboratory. Positions available, September 1956. Location, South. W-2717.

EDITOR, graduate civil for national construction magazine. Prefer someone who has had about 1½ years' experience; must have capacity or clear, concise writing. Salary open. Location, New York, N.Y. W-2720.

STRUCTURAL DESIGNER, experienced in large central station power plant or heavy construction. Graduate civil or structural engineer; 10 to 15 years' experience; registered civil or structural engineer in state of California desirable but not necessary. Must be capable of directing activities of structural designers and detailers. Salary, $10,000–$12,000 a year. Location, Midwest. W-2753.

ENGINEERS for the design and supervision of construction of major hydroelectric projects. (*a*) Assistant and Project Managers to take charge of the project construction. (*b*) Construction Superintendents and Assistant for field engineering, inspection, etc. (*c*) Electrical, Mechanical, and Civil Engineers to take charge of electric and mechanical inspection, and inspections of foundations and concrete. Applicants should have extensive experience on the construction of hydroelectric plants. Location, United States and abroad. W-2768.

FIELD ENGINEER, graduate civil, 30, for close supervision and inspection work on construction projects and for design engineering and drafting. A number of years' experience in each is preferable. Work consists of minor industrial building and apparatus foundation and support design both new and for alterations, and the scheduling, coordination and overall inspection of the work of contractors doing such work. Salary open. Location, New York area. W-2781.

ENGINEERS. (*a*) Structural Engineers, 35–40, with 7 to 10 years' experience in structural steel, to supervise structural group in construction and design department, designing structures, etc. (*b*) Structural Designer, 25–35, with at least 5 years' experience in structural steel and concrete design for industrial plants. Must be willing to work at drafting board in the construction and design department when required. Salaries: (*a*) to $9,000 a year, (*b* and *c*) to $6,500 a year. Locations, upstate New York. W-2783.

STEEL FABRICATION ENGINEER, B.S. in civil engineering, 30–45, preferably with California C.E. license, or able to acquire it, with several years experience in design and fabrication of structural steel and miscellaneous iron. Take charge of drafting room, work with shop superintendent, and handle engineering contacts. Salary, $9,600 a year. Location, San Francisco East Bay. S-174.

HIGHWAY ENGINEER, to 48, professional engineer and broad knowledge of highway engineering gained in state, county or city engineering employment. Must be able speaker and writer; assist in formulating and promoting highway programs in South California. Opportunity for advancement. Salary open. S-179.

PROJECT SOIL ENGINEERS, Senior and Junior, M.S. in soil mechanics for consulting soil and foundation engineers. Salary, open. Location, New York Metropolitan area. W-2806.

STRUCTURAL ENGINEERS AND DRAFTSMEN, for consulting engineer-architect office. Industrial and commercial building experience desirable. Location, Ohio. W-2741-D.

Bibliography on Machinery Foundations

The Engineering Societies Library announces its new Bibliography (No. 11), which provides annotated references from 1924 to 1955 on machinery foundations —design, construction, vibration elimination.

Copies available at $2 each

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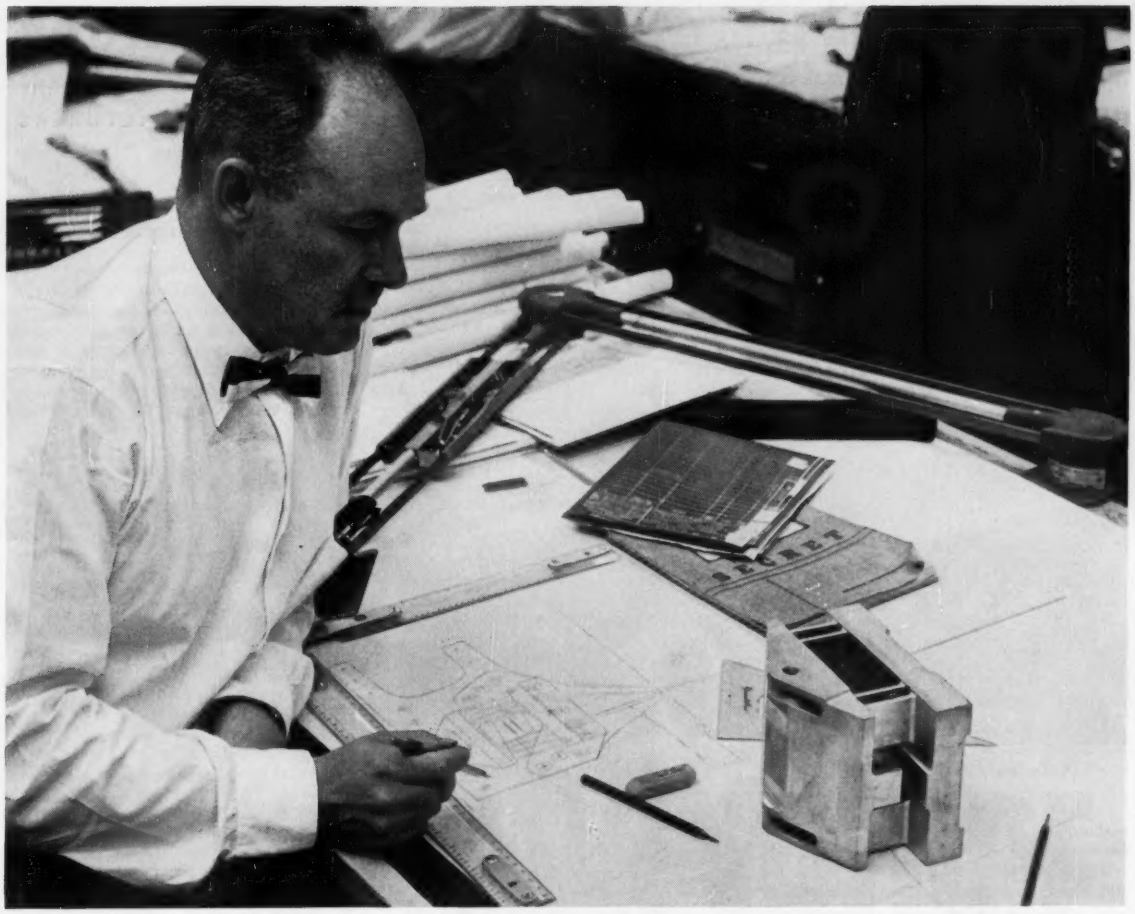

Thrust gage design is this Boeing engineer's "baby"

From layout to missile firing, this project is a Boeing engineer's responsibility. His assignment: to design an engine mount that will isolate from other loads and measure within ½ of 1% accuracy the tremendous in-flight thrust of a guided missile.

The mount, called a thrust gage, must fit engine and airframe without modification of them, and must "grow" equally in all directions during a temperature rise of several hundred degrees in less than a minute. The object: a stronger mount weighing less than half the present one.

This is typical of the challenging and creative assignments given Boeing civil engineers. There are more than 500 of them. And more are needed for years-ahead Boeing projects in structural and flight testing, thermo and fluid dynamics, stress analysis, and many other fields.

This engineer is finishing his layout, with the preliminary mockup before him. Next, he will supervise draftsmen and engineering aides in final drawings. Then he will work closely with other engineers in production, structural testing, instrumentation and telemetering. Creating this thrust gage gives him responsibility, career growth, and a real sense of professional achievement.

Boeing engineers have career stability in a soundly growing company that now employs more than twice as many engineers than at the peak of World War II. Living is pleasant for them in the progressive, comfortable-size communities of Seattle and Wichita.

These men take satisfaction in knowing they're on a winning team that has created such aviation milestones as the new 707 jet tanker-transport, the giant B-52, and the Boeing B-47, "backbone" of Strategic Air Command. There's a rewarding job awaiting you now at Boeing in design, research or production.

JOHN C. SANDERS, Staff Engineer— Personnel
Boeing Airplane Co., Dept. D-48, Seattle 14, Wash.

R. J. B. HOFFMAN, Administrative Engineer
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EQUIPMENT, MATERIALS and METHODS

NEW DEVELOPMENTS OF INTEREST AS REPORTED BY MANUFACTURERS

Automatic Roadbuilders' Plant

COMPLETE AUTOMATION FOR CONCRETE BATCHING plus portability is displayed in an automatic Roadbuilders' Plant. Batching of all materials is controlled by one man, stationed at the cement batcher, operating a simple set of push buttons. If desired, the truck driver can operate the sand and aggregate batchers separately

Completely Automatic Plant

without leaving his cab, through push button control mounted on the bin columns.

The new plant assures quality control and absolute accuracy. Two batches of sand, cement and both sizes of stone are weighed and discharged simultaneously. Every batch must be right because all gates are interlocked so that they cannot discharge until the correct weight is in the hopper, nor can the hoppers be charged until all material is out. Master controls governing any selected and specified batch proportions are located at the rear of the bin. These are pre-set for the concrete specifications and need not be touched again until resetting for new specifications, when they can easily be changed. Entire unit can be set up in a few hours. In transport the complete unit ships in one piece. **Butler Bin Company, CE-2-110, Waukesha, Wisc.**

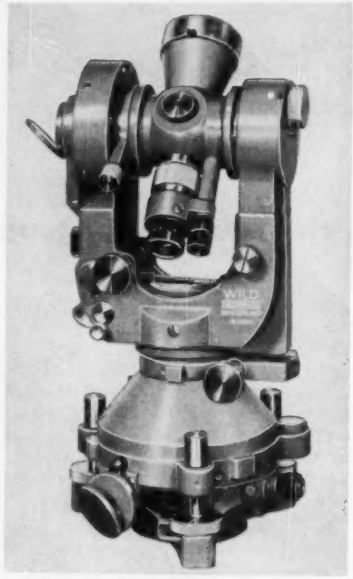
Separator Machine

REPLACING THE CONVENTIONAL METHOD of the shaker screen system used in the separation of materials, is a new separator machine which sieves materials more rapidly by giving a gyratory motion to the screen. The unit is capable of a throughput of up to 12,000-gal per hour straining with 120 mesh, and will work efficiently with meshes as fine as 200. The complete machine is a compact unit 5-ft, 7-in. long, 35-in. wide and 31-in. high. A $^3/_4$-hp electric motor drives the mechanism which generates the gyratory motion to the straining frame.

The Separator has been successfully applied to the dewatering of tar used in the surfacing of roads. It strains the material through a fine mesh, separating the solid material in suspension and partially breaking down the emulsion with the result that the tar thus processed can readily be dewatered by centrifuging. **Russell Construction Ltd., CE-2-110, 8 Adam St., London, England.**

Universal Theodolite

TEN ACCESSORIES, ELECTRICAL ILLUMINATION, AND DISTANCE MEASURING with the use of the Invar subtense bar are designed to reduce to a minimum both the number of personnel and time spent on field parties. Major accessories include targets for precise traversing with automatically controlled centering, optical plumb line, precision range finder, eyepiece prisms,



Model T-2

diagonal eyepieces for observations under very high angles, and a striding level for direct measurement of trunnion inclinations. Others are attachments for determinations of meridian, longitude and latitude, and a base plate for setting up the instrument on a pillar. The Theodolite is adapted for all triangulations to the third and second order, and for precise surveys of every kind. **Wild Heerbrugg Instruments, Inc., CE-2-110, Main at Covert Sts., Port Washington, N. Y.**

Double-Ended Pump

A NEW DOUBLE-ENDED 3-HP PUMP is the latest addition to the company's line of canned motor pumps for leakproof handling of corrosive, toxic, explosive, radioactive and other hard-to-handle liquids. Basically a two-stage pump, the pumping chambers can be piped in series or parallel for remarkably compact high head or high

2-Stage Pump

volume pumping. Overall size of the pump is less than two, by one, by one and a half ft, yet it gives heads to 230-ft.

Already in extensive service handling titanium tetrachloride, the new pump is available in cast iron, cast steel, 300-series stainless steel, Monel and Carpenter-20. Standard temperature and pressure limits are 450-deg F and 300-psi, respectively. **Chempump Corporation, CE-2-110, Station J, 1300 East Mermaid Lane, Philadelphia 18, Pa.**

Reflective Street Signs

PREPARED REFLECTIVE STREET-NAME SIGN FACES made to order for cities and counties are visible at night under auto headlights as far as one block away. The manufacturing company says cities with trial programs underway report enthusiastic public response to the reflective street-name signs. Made of "Scotchlite" brand reflective sheeting with the street-name silk-screened in contrasting reflective colors, the ready-to-use faces are designed for shop refurbishment of existing non-reflective street-name signs, or making new signs.

The reflective faces are prepared on 24-by-24-in. pieces of reflective sheeting, with four street-name signs on each sheet. The city or county sign shop personnel cut the faces apart, then adhere them to the sign backing. A weatherproof adhesive on the back of the sheeting bonds the face to the metal backing. Though the manu-

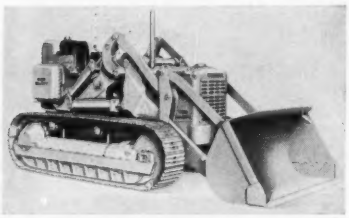
facturer's standard is green letters on a silver background, the faces can be prepared in any color combination desired. For orders of 25 sign faces or more, there is no charge for the special set-up for screening the various street-names. **Minnesota Mining & Manufacturing Co., CE-2-110, 11, Dept-5-357G, 900 Fauquier St., St. Paul 6, Minn.**

Nylon Bob Cord

A NEW 50-LB TEST YELLOW NYLON CORD has been added as a standard accessory on all transits manufactured by this company. The new cord greatly increases the visibility of the plumb bob string, especially in conditions of poor lighting, and the wear quality of the nylon is superior to the linen usually used. The company is also distributing a small metal cord adjustor, which enables the instrument man to make quick changes in line length while on the job in the field. A set of cord and adjustor, with illustrations showing how to use the two together on any transit, is available for 25 cents. **W. & L. E. Gurley, CE-2-111, Troy, N. Y.**

Traxcavator

THE ADVANTAGES OF integral tractor and shovel design have been incorporated in the largest Traxcavator in this company's expanding line of tractor-shovels. All of the advance design features that are in the company's other models have been included in this larger version, No. 977. Such features include unit design, 40-deg bucket tip-back at ground-level, large



Model No. 977

lifting capacity, good balance and stability, improved operator visibility, fast response to controls, in-seat starting and oil flywheel clutch.

A 60-gal fuel tank is used, while forward speeds up to 651-ft per min and reverse speeds up to 616-ft per min can be obtained. The overall dimensions of this 100-hp Traxcavator are: length 17-ft; width 8-ft; height 7-ft, $3^3/_4$-in.; ground clearance 1-ft, $4^1/_2$-in. **Caterpillar Tractor Co., CE-2-111, Peoria, Ill.**

SONOTUBE®-formed concrete columns save time, money and labor on this dormitory!

Men's Dormitory, Michigan State University, East Lansing, Mich. Christman Co., contractors; Ralph Calder, architect.

SONOTUBE®

FIBRE FORMS

for round columns of concrete

Low-cost SONOTUBES formed the round concrete columns for this Michigan State University building as they have for great numbers of similar type institutional structures all over the country.

SONOTUBE Fibre Forms are used to form piers, piling, underpinning and other structural elements in many types of construction.

Contractors and engineers know that SONOTUBE Fibre Forms require minimum bracing, handle easily and can be sawed to specific requirements on the job. Contractors' cost records are proving over and over again that SONOTUBES save time, labor and money!

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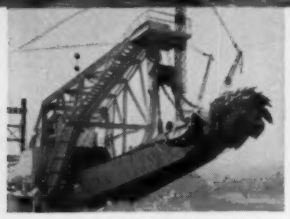

Dredge Franciscan is 207′ long, digs 50′ deep, with ladder at 45°, pivots in 350′ arc on one of two 80′ spuds, has seagoing stern. Present power comes from shore, but design provides for installation of on-board power plant.

The cutter head on the Franciscan has a 1,500 hp. motor.

DESIGNED AND BUILT BY YUBA
Hydraulic dredge for 11 million yard sand fill

Dredge Franciscan (Yuba No. 170), built for The Utah Construction Co., is the largest, most powerful suction dredge on the West Coast. It has 9 ft. cutter head powered by 1,500 hp. motor, 36″ intake and 30″ discharge with 8,000 hp. motor on pump. Its immediate job: Filling 390 acres of Alameda (Calif.) tideflats with 11,000,000 cu. yds. of sand for future homesites. Following this job, Dredge Franciscan will fill 24,000,000 yards on adjacent tidelands at Bay Farm Island.

1,500-horsepowered cutter on the dredge successfully tears apart "Alameda sandstone," a very tight formation heretofore handled inefficiently by other hydraulic dredges. Its big pump thrusts sand and silt nearly two miles at a rate that will easily complete the 11,000,000-yard fill in the scheduled year. The entire dredge is operated by one man from a central control room.

If you have hydraulic fill, channels or harbors to excavate, or levee construction, consult Yuba. To your problem, Yuba applies 50 years of building bucket ladder and hydraulic dredges, plus more than 30 years of experience by George Pelton, Yuba consultant on hydraulic dredges. Wire, write or call us NOW— no obligation, of course.

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YUBA DREDGES — PROVED DEPENDABILITY AROUND THE WORLD

EQUIPMENT MATERIALS and METHODS

(continued)

X-Ray Unit for Weldments

MAKING POSSIBLE THE WIDER USE OF RADIOGRAPHY in weld inspection, a spot-check X-ray unit is being introduced. The basic design feature of the unit is its extremely low weight-to-power ratio. The lightest unit available for its rating, the X-ray head weighs only 46-lb and provides a power penetration of 140-kvp. The entire unit, which comprises the X-ray head and control panel, fits inside a trunk 32-in. long. Named the Baltospot, the unit provides spot-check radiographs up to a capacity of $1^1/_2$-in. steel or the equivalent. It is intended to be used in place of or as an alternative to sectioning methods of inspection. **Balteau Electric Corp., CE 2-112, Stamford, Conn.**

Sign Spans

A SIGN SPAN IS BEING PRODUCED in which a new type of aluminum fabrication recently developed is being used. Supporting shafts are seamless, tapered all aluminum, with the span all welded of individual sections. The unit is 48-ft and has been tested under loadings of 60-lb per running ft and 105-mph wind loads. This is the first time such construction has been utilized in all aluminum over-the-road spans. The result is a truly light weight, easy to install structure that is free from cumulative corrosion and subsequent weakening, plus a permanently attractive appearance. The inherent and structural flexibility of the new spans offer exceptionally high resistance to storm and damage. **Pfaff & Kendall, CE 2-112, 84 Foundry St., Newark, N. J.**

Adjustable Masonry Scaffolding

TWO MAJOR CONSTRUCTION CHANGES IN SCAFFOLDING are being announced. The first is a greatly increased load rating for the basic 10-ft tower and in the tower extensions, almost double the figure of previous towers. The second major change is an extension for the laborer's platform to accommodate the increasing use of mechanized material handling equipment. The platform is extended to accommodate carts, wheel barrows, lifts and working from conveyors. The Adjustable Scaffolding is equipped with triple platforms for masons, tenders and materials and moves up mechanically with the job. The scaffolding has to be set up only once, and the mason is kept at his most efficient working level at all times. **Morgen Manufacturing Company, CE 2-112, Yankton, S. D.**

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SOLIDIFICATION

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into Shafts, Heavy Building Pits, Structures
TO STOP
• SETTLEMENT of FOUNDATIONS
TO SEAL
• LEAKY CONCRETE STRUCTURES
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TUNNEL & SHAFT LININGS,
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EQUIPMENT MATERIALS and METHODS

(continued)

Rear Dump Trailer

OFFERING A CAPACITY OF 15.6-CU YD, speeds up to 31-mph, right or left angle turns of 90-deg, and simply designed, 3-stage hydraulic hoists which tilt the body 60-deg for quick, positive ejection of any materials, a new rear dump trailer, the PR

15.6 Cu Yd Capacity

15, is a mate for the Cat DW 15 tractor. The entire loaded unit weighs 84,683-lb with 37% of the load on the big drive wheels of the Cat 186-hp tractor. Engine, tractor, trailer and tires are matched in design to provide low cost performance. Large single tires are interchangeable with tractor drive and trailer. Dumping can be accomplished on the go; discharge lip extends well beyond rear wheels to cast loads over edge of fill. **Athey Products Corporation, CE-2-113, Chicago, Ill.**

Perigraph

A NEW DEVICE makes it possible to obtain the cross section of any mine gallery, road or railway tunnel, and vertical mine shaft during boring operations. It is possible with this single apparatus to measure the smallest (4 sq m) to the largest (50 sq m) cross section. The plottings are used to predetermine the quantities of lining concrete required, to measure the area of surfaces to be coated with cement gun, and to keep a permanent check on the strains and deformations of existing tunnels and galleries. In addition, it is used to check tunnel gauges obtained, comparing them with design cross sections to determine that work is progressing according to direction.

The apparatus is mounted on a four wheel base trolley for operation on 0,60 and 0,75m gauge tracks. For transport the perigraph is divided into three cases that may be assembled and ready for use in less than ten minutes. The complete perigraph includes the telescopic pedestal, mobile unit, drawing panel and contact pointer elements. **F. Bordes, CE 2-113, 15, Route de la Chartreuse, La Tronche, Isere, France.**

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TEN SECOND THEODOLITE
(With Optical Micrometer)
is built with traditional Swiss craftsmanship incorporating the latest technical advances giving the modern engineer
ACCURACY AT A GLANCE
DESIGNED FOR land surveying, big construction and engineering operations spot checking.
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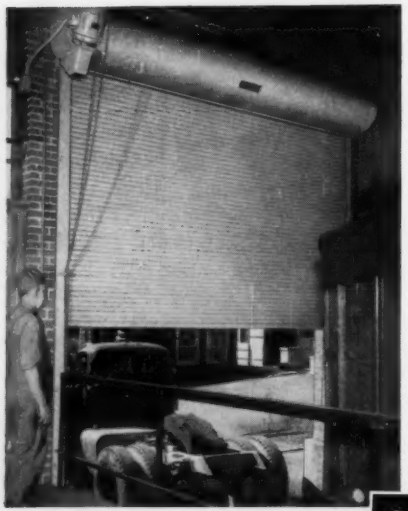
Kinnear Rolling Doors



Here is a **BIG** factor often overlooked by cost-minded business and industry: The floor and wall space . . . the time and labor . . . the upkeep and repair costs you can save with Kinnear Rolling Doors.

Opening straight upward, they coil out of the way. Their rugged, all-metal, heavily galvanized construction withstands hardest use . . . toughest weather conditions. Built any size, with manual or electric operation. Ideal for old or new buildings of any type.

Write for details on Kinnear Rolling Doors—the BIG value in door efficiency.

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Saving Ways in Doorways
KINNEAR
ROLLING DOORS

EQUIPMENT MATERIALS and METHODS

(continued)

Bituminous Plant

THE MAIN FACTOR contributing to the increased adaptability of a new bituminous plant is a four compartment bin which allows greater latitude and flexibility in the composition of aggregate fed to the

Model 102

mixer. On jobs where less than four sizes of aggregate are sufficient, the bin can be easily converted to production. Unusually large proportions of any particular size can be attained by combining compartments. Production capacity of the Model 102 continuous process plant ranges up to 200 tons per hour, depending on material conditions. It has only two main units: a combination drier-dust collector and a combination gradation-mixer, each compactly assembled in a straightline on a single chassis. **Pioneer Engineering Works, Inc., CE 2-114, 1515 Central Ave., Minneapolis 13, Minn.**

Vibrating Rollers

NEW VIBRATING ROLLERS mark a practical and proved application of sound engineering principles to the theory of compaction by vibration. By utilizing high frequency vibrations, these rollers produce a consolidation of all types of granular materials and asphaltic paving materials not possible with dead weight rollers. The vibrating rollers are produced in three sizes: the 28-in. hand-operated, self-propelled roller, the 32-in. self-propelled tandem vibrating roller, and the 54-in. trailer type vibrating roller. They will give compaction in excess of 95% of the AASHO tests.

Small enough to work easily around the narrow confines of bridges and building construction, the model VR-54 has proved superior in the vibration of fine materials for water bound base for macadam. In the consolidation of asphaltic paving materials, the 28-W, weighing only 675-lb, gives compaction in excess of that obtained by a 5-ton dead weight roller, while the 32-R, weighing 1,700-lb, gives greater compaction than a 10-ton dead weight roller. **The Essick Manufacturing Company, CE-2-114, 1950 Santa Fe Ave., Los Angeles 21, Calif.**

Why Cement Gels Concern You . . .

What is a Cement Gel?

A cement gel is a jelly-like swelling that occurs around each grain of portland cement when water is added to the concrete mix. It is the initial reaction product between cement and water. The gel is the controlling factor in cracking, uniformity and structural quality of concrete.

The cement gel imparts fatty and cohesive properties to the mix. As hydration of the cement proceeds, the gel partly crystallizes and, on drying, reverts to almost the original cement grain size.

Gel size and hydration vary widely, depending upon water and temperature. It is this difference that causes variations in the quality of concrete for a given mix design.

In the heat of summer gels form faster and larger. Large gels absorb more water from the mix. Thus, more mixing water is required for adequate workability. The resulting concrete has poorer quality. As water is consumed by hydration and lost through evaporation, internal stresses are created. These eventually result in shrinkage cracks.

In cooler weather gel formation is retarded. Smaller gels are formed, and less mixing water is needed. Concrete quality is proportionately better. Less shrinkage occurs, the concrete is more dense and has higher structural quality.

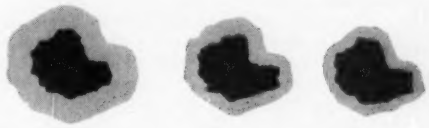
Thus, the gel is the governing factor in controlling the uniformity, structural quality and cracking of your concrete.

Cement Gels Can Be Controlled

The size and action of the cement gel can be controlled chemically with a gel-reducing agent developed exclusively for this purpose, Plastiment Concrete Densifier.

Plastiment reduces gel size and retards hydration in direct proportion to the quantity added. This effect is uniform and predictable with all types of concrete. Changes in mix design, aggregate graduation, use of air entraining or other additives do not affect its action. Results of this controlled gel size are: higher density, higher compressive strength, higher bond to steel and reduced cracking.

With this constant predictable effect, it is logical to keep the gel formation and setting time uniform by increasing the quantity of Plastiment as temperature rises. In this way, Plastiment offsets the damaging effects of high temperatures.



CEMENT GEL 90°F. | CEMENT GEL 50°F. | PLASTIMENT-CONTROLLED CEMENT GEL

Smaller chemically-controlled gels result in an exclusive rapid clear water bleeding action, without scum and laitance being carried to the surface. This acts as a safety factor should concrete receive an over-dose of water at the job-site.

Plastiment is thoroughly dependable and performs exactly as stated. For this reason, Plastiment has been the logical choice of top structural designers for most of the floating concrete structures and large prestressed structures in the world today, as well as a great variety of other structures where uniformity and high quality of the concrete is essential.

Plastiment offers each engineer a dependable tool for controlling setting time, uniformity and cracking in concrete.

Let Plastiment Work for You

Our engineers will be glad to tell you how Plastiment can help you on your current job. For more detailed information on Plastiment's action on the cement gel, write today for a copy of the illustrated booklet "Plastiment Concrete Densifier."

Sika

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SIKA Chemical Corporation, Passaic, New Jersey

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How seismic surveys saved time and money for the Connecticut Expressway

Ammann & Whitney needed to know depth to bedrock along the center of all major cuts of the 129-mile Connecticut Expressway—in a hurry. A Gahagan 4-man Seismic Survey Crew gave the answer in just 30 working days. Gahagan Seismic Crews also worked with Section Engineers Knappen, Tippetts, Abbett, McCarthy, and Loomis & Sullivan. The latter firm, for instance, used a continuous profile of bedrock elevation, right and left of centerline, to draw up definitive cross sections every 50 feet. This expedited planning by two-thirds the usual time and gave a wealth of data that would have cost about four times more if obtained by other means. Write for Bulletin 2 giving facts about seismic survey use with highways, dams, power plants, bridges and other construction projects. Address Geophysical Survey Division, Gahagan Dredging Corporation, 90 Broad St., New York 4, N. Y.

Established in 1898, Gahagan is a leader in hydraulic dredging

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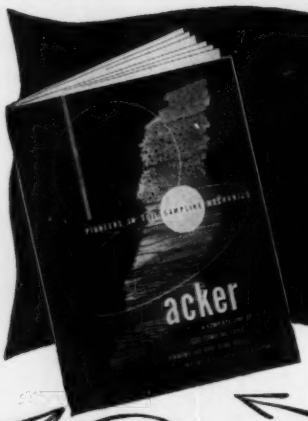

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EQUIPMENT MATERIALS and METHODS

(continued)

Flush Diaphragm Pressure Transducer

A MINIATURE FLUSH DIAPHRAGM PRESSURE TRANSDUCER of the variable reluctance type, the Model AP-17, has been developed primarily for flight test application. It is also used in measurements and controls with indicating, recording, and control systems adapted to operation with this type of transducer. Ranges extend from 0-15 psi to 0-5000 psi absolute and the dynamic characteristics permit flat response from static to extremely high frequencies. The absence of mechanical coupling between the diaphragm and pick-off, and the rigidity of the internal assembly results in high natural frequency and freedom from spurious mechanical resonance. The instrument is temperature compensated for sensitivity and zero shift to hold calibration change within one percent full scale per 100-deg F between 65 and 250-deg F. **North American Instruments, Inc., CE 2-116, 2420 North Lake Ave., Altadena, Calif.**

Field Assembled Wall Panel

A NEW PRODUCT, a field assembled wall panel designated as Type FA, is available in an aluminum model, either in a mill or leatherette finish. The components of the panel unit can be shipped to the job site where erection and fabrication take place at the same time. This method can lead to greater economy than has previously been possible in light gage metal, curtain wall construction.

The only tools necessary for the field assembly are a molly bolt spreader, a power drill, a hammer and a riv-clinch tool. This assembly technique produces a panel that is 24-in. wide, $3^1/_4$-in deep, and with lengths up to 31-ft. The FA panel is available in 16-gage aluminum and 18-gage galvanized steel. Ease and simplification of erection have been given equal precedence with structural and architectural considerations. **Detroit Steel Products Company, CE-2-116, Fenestra Division, Detroit, Mich.**

Portable Welder

A PORTABLE WELDING MACHINE designed specifically for manganese steel and hardfacing work on irregularly shaped parts is now available to industry. Mounted on large industrial casters and displacing no more space than an average

(*Continued on page 118*)

SHOPPING CENTER TEXAS STYLE... BIG

GULFGATE SHOPPING CITY, Houston, Texas. *Architect:* John Graham and Company, Seattle. *Contractor:* Farnsworth and Chambers.

840,000 SQUARE FEET OF SPACE!

Gulfgate Shopping City near Houston, established by Allied Stores Corp., is like most things in Texas . . . big. The $20,000,000 project will house 90 to 100 stores, including Joske's department store with 207,000 square feet of space. Overall, there are 840,000 square feet, facilities to park 20,000 automobiles a day. Fabricated steel for this gigantic, modern development was furnished by Ingalls.

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Delivered the exact lengths of MP116 piling needed to prevent any danger of losing a dam through river floods or cave-ins on this cofferdam job. An efficient delivery assured contractors Brown & Root an uninterrupted work schedule.

Cofferdam construction for AUSTIN, TEXAS POWER HOUSE on Banks of Colorado River. Steel-sheet piling, supplied by L. B. Foster Co., was used in 35 to 40 ft. lengths to make up the cofferdam which will be filled with 120,000 cu. ft. of concrete.

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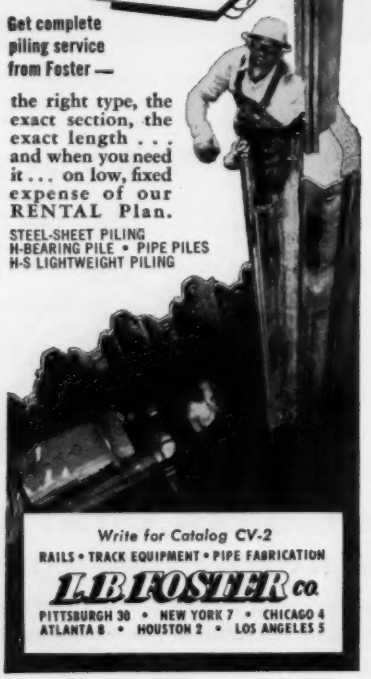

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EQUIPMENT, MATERIALS and METHODS

(continued)

floor model television set, the MF welder is designed to plug into conventional AC or DC welding units by a single cable.

Welding wire is fed automatically through the flexible cable at a rate governed by the size of the welding arc, and flux is fed through the cone-shaped hopper above the weld contact. Flux, which is available in several compositions to give varying welds, adheres magnetically to the weld wire. The MF is recommended for hardfacing work in particular, as well as more conventional welding, and is being used in servicing and repairing equipment in construction, highway building, and industrial maintenance. **American Brake Shoe Company, CE-2-116, 118, American Manganese Steel Division, Chicago Heights, Ill.**

Scraper

A NEW TWO-WHEEL HYDRAULIC SCRAPER, which has been tested and approved for mounting on the 300 Utility tractor, is now available. The scraper, hydraulically controlled from the driver's seat, has a capacity of $^{5}/_{8}$-yd. The 66-in. wide cutting

900-lb. Scraper

blade extends beyond the wheels and sides of the scraper enabling unlimited digging depth. The scraper is ideal for digging small excavations, leveling, building small roadways, cutting drainage ditches and general clean-up work. The unit weighs 900-lb. **Shawnee Manufacturing Company, CE 2-118, 1947 N. Topeka Ave., Topeka, Kansas.**

Forming Tools

THREE NEW ADDITIONS to a line of forming tools for the commercial builder have been announced. A new flat tie form can be stripped by merely disengaging connecting bolts and hinging form away from wall. Galvanized strips have been employed extensively to prevent splitting of side rails and the form is strengthened by H-frame construction. Sizes range in lengths of 6, 7, and 8-ft, and in widths of 30, 36, 42 and 48-in.

The adapter plate makes it possible to insert ties internally at various points within the panel. Only the connecting bolt is necessary to secure the tie at these points. The new flat tie may be easily broken back $^{1}/_{4}$-in. in the wall with a few hammer blows. When necessary, it can be installed quickly and efficiently from the outside of the form. Grout leakage is reduced because the tie fits snugly into the tie slot. Exact wall size has been stamped on each tie to avoid errors. **Symons Clamp & Manufacturing Company, CE-2-118, 4249 West Diversey Ave., Chicago 39, Ill.**

Tire Changing Tool

A NEW HYDRAULIC TIRE CHANGING TOOL, known as the TO-100, is the only portable tire changer on the market applicable to all makes and designs of earth-moving rims for either tubeless or conventional tires. This new tool is ideal as standard equipment on construction job service trucks. It can be used on the job anywhere for changing or mounting earth-mover tires, up through the largest sizes, reducing costly down-time for big earth-moving vehicles. **Goodyear Tire & Rubber Company, CE-2-118, Akron 16, Ohio.**

A New Kind Of Concrete

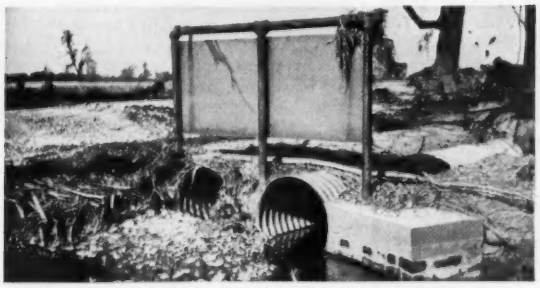
A CHEMICAL AND A PROCESS which permit the manufacture of a light weight concrete that is strong, self-insulating, highly moisture-resistant and adaptable to many uses is now being introduced in the United States and Canada.

Elastizell is compounded of two basic ingredients: a foaming agent and a water soluble plastic agent. When they are mechanically mixed with wet concrete, in a special mixer, the result is a homogeneous cellular or bubble structure, light in weight because of the introduction of a high volume of air. The plastic agent gives the cells or bubbles a coating of high tensile strength. The homogeneous structure results in a uniform strength, thus reducing the possibility of cracking due to varying strengths or densities throughout the mass.

Other advantages of this new concrete are that it is imcombustible, non-corroding to steel, dry with a warm-to-the-touch-feel, and extremely flexible in application. **Elastizell Corporation of America, CE-2-118, 15555 W. McNichols Rd., Detroit 35, Mich.**

Twin Armco Pipes Are 49 Years Young

Twin Armco Pipes, installed in 1907, as they look today.



Flood in 1913 washed out the road, but left pipes undamaged. Same thing happened two years later.

In 1919 the pipe got a new concrete headwall and the highway was resurfaced with brick.

In 1907, these twin 24-inch-diameter Armco Corrugated Metal Pipes were installed under a well-traveled Ohio road. Today, 49 years and 2 devastating floods later, they are in excellent condition with many years of useful service life ahead of them.

Of course, this early installation of Armco Pipe was light gage and had only a galvanized coating for protection. Countless improvements have been made since then. Today, you can select from a variety of Armco drainage products and coatings designed to withstand almost any degree of loading, corrosion or erosion. Imagine then, how many more years today's improved Armco Structures should last compared with this 1907 corrugated metal pipe.

Durability is a feature of Armco Drainage Structures. Equally important is that Armco Structures have a low initial cost and allow installation economies. No special skill is needed for assembly; jobs go fast.

Armco Pipe is available in diameters ranging from 8 inches to 15 feet, in a variety of gages. Armco Pipe-Arch Structures are supplied in comparative sizes. Write for more data. Armco Drainage & Metal Products, Inc., 3716 Curtis Street, Middletown, Ohio. Subsidiary of Armco Steel Corporation. In Canada: write Guelph, Ontario. Export: The Armco International Corporation.

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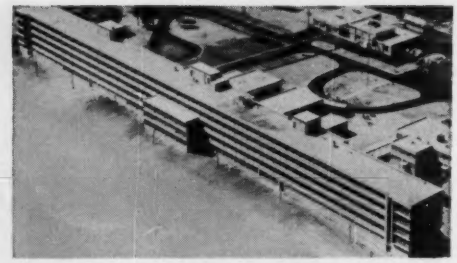

General view of new tuberculosis sanitorium in Tampa, Fla., for which Connors supplied concrete reinforcing bars. Arnold Construction Company of Palm Beach, Fla., was General Contractor.

Your building site in the Southeast is only a few short hours from Connors' centrally-located plant.

In addition, Connors has all the other essentials for better service, including ample bar inventory and accurate fabricating shop adjacent to rolling mills.

These factors, plus Connors' traditional follow-through from start to finish, are your assurance that your reinforcing steel will be on the job when you need it . . .

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The two photographs show the Bulls Bridge Dam of the Connecticut Light and Power Company, which is one of many dams we have repaired for this company.

The upper view shows the work in progress, and gives some idea of the condition of this structure before repairs were made. The lower view is of the completed job.

After chipping out the loose and disintegrated concrete and sandblasting the entire area, heavy reinforcing mesh was placed over the surface of the old concrete and "GUNITE" applied two inches thick, plus the material re-required for filling deeply eroded portions.

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LITERATURE AVAILABLE

CLARIFIERS AND THICKENERS—Questions on design requirements of clarifiers and thickeners for a wide range of capacities and solids removal loads are informatively answered in a 16-page, easy-to-read, graphically illustrated booklet. The bulletin explains fully why circular sedimentation basins, sludge scrapers and central inlet wells are features of these clarifiers and thickeners. **Infilco, Inc., CE 2-120, Tucson, Arizona.**

MAINTENANCE AND CARE—Practical help for clamshell bucket operators is graphically presented in a new bulletin reported to be the most comprehensive work of its kind ever issued by any bucket manufacturer. It contains 40-pages of illustrations and carefully indexed information including: cable life, as influenced by sheave diameters, or proper application of tag line, or application to crane; how to use counterweights for maximum efficiency; and when to increase bucket reeving. Also included are welding procedures for building up worn cutting lips, repairing fractures in high carbon plate and cast alloy steel, and a section on what makes bucket lips bend in or bow out. Among numberous other items in Bulletin 2373-R are a list of common abuses leading to early bucket failure and proper lubrication practices. **Blaw-Knox Company, CE 2-120, Bucket Department, Pittsburgh 38, Pa.**

TOPOGRAPHIC MAPPING—A new release explains the photogrammetric method of mapping and analyzes the uses and advantages of topographic, planimetric and mosaic maps. Maps and studies are shown from actual surveys and projects, including the U. S. Air Force Academy survey, which involved mapping 17,500 acres of Rocky Mountain terrain. In addition, a special section describes in detail the process of compiling a map from aerial photographs. This 10-page colored booklet includes a list of special services for clients. **Alster & Associates, Inc., CE 2-120, 6135 Kansas Ave., N. E., Washington 11, D. C.**

PRODUCTS HANDBOOK—A 52-page publication features eleven lines of industrial products: packings and gaskets, insulations and refractory products, transite asbestos-cement pipe, electrical products, Celite Diatomite filter aids and mineral fillers, Celite Diatomite catalyst carriers, metal raschig rings, synthetic silicates, friction materials, pipe protection materials, floorings, roofing and sidings. The handbook contains not only product descriptions and essential engineering data but also a great deal of valuable related information, such as different methods, tables and graphs. **Johns-Manville, CE 2-120, 22 E. 40 St., New York 16, N. Y.**

TIDE GATES

Fig. B-124-D

Two 60" Type M Gates on Relief Culverts near Woodward Pumping Station, Plymouth, Pa.

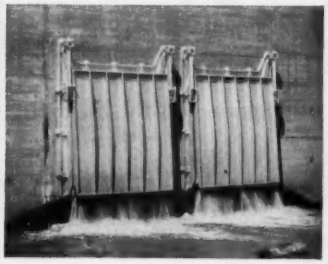

Fig. B-124-C

Two 72" x 72" Type M-M Gates on Toby Creek Outlet Works, Plymouth, Pa.

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RESIDENTIAL PIPING—"Piping Security for the Home" is the title of a new 8-page booklet prepared for builders, contractors and others who select piping for residential applications. The new book emphasizes the importance of piping in residential construction and describes how the special properties of wrought iron pipe measure up to basic requirements of dependability and economy in residential piping services which are subject to corrosive attack. Piping economy is discussed on the basis of materials cost, installation cost, and maintenance expense. Photographs illustrate the unique mixture of high purity iron and glass-like silicate fibres that gives wrought iron unusually high resistance to corrosion and fatigue. **A. M. Byers Company, CE 2-121, Clark Bldg., Pittsburgh 22, Pa.**

TRAFFIC CONGESTION—A prescription for curing traffic congestion by the use of rapid transit is given in a new bulletin, GEA-6389. Beginning with the cause of today's traffic problems, the 16-page, two-color publication gives a complete discussion of how drivers can be converted into transit riders, what a transit system should consist of, why expressways alone won't solve the problem, and how expressways and transit can work together. This comprehensive bulletin is completely illustrated with photographs and charts. **General Electric Company, CE 2-121, Apparatus Sales Division, Schenectady 5, N. Y.**

GRATING AND STAIR TREADS—An illustrated report on the usage of steel, aluminum and stainless grating and stair treads has just been published. The report, in brochure form, discusses the various types of electro-forged welded grating as well as offering dimensional sketches and data on riveted grating. Bridge decking is also discussed and an illustrated series is given on the various types of anchors suggested for grating illustrations. A detailed safe load table with conversion factors, panel width constant chart and data on the standard widths and types of steel stair treads most frequently used are recorded in the pamphlet. **Klemp Metal Grating Corporation, CE 2-121, Dept. SP, 6601 So. Melvina Ave., Chicago 38, Ill.**

DRILL SUPPLIES—A new 40-page catalog contains a complete and up-to-date listing of all drilling tools, accessories and supplies used for soil sampling, foundation test boring, core drilling and coal and mineral prospecting. The book is divided into seven sections for easy reference and contains a detailed index as well. Photographs, diagrams, and specifications accompany each item. **Acker Drill Co., Inc. CE 2-121, Scranton 3, Pa.**

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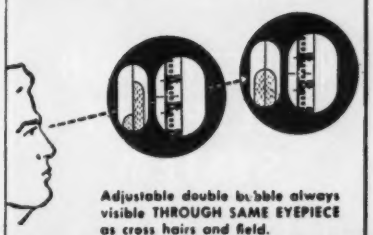

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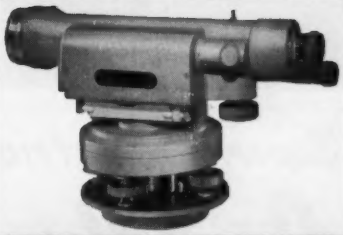

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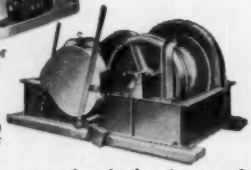

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From the MANUFACTURERS

LARGEST RENOVATING JOB EVER: Power-actuated fastening tools are being used in the renovating of a 20-story office building in New York. A whole new building is being constructed on the foundation of the old one. The tools, made by the Ramset Fastening System, are being used to fasten the new aluminum curtain wall exterior as quickly as possible . . . **UNIQUE SERVICE TO WELDING INDUSTRY:** Lincoln Electric Company is now remanufacturing old welders on a production line basis to meet the demands of many companies for peak production efficiency. The revamping costs half the price of a new machine . . . **PLANT EXPANSIONS:** The new plant of Napco Industries, Inc., of Minneapolis will provide 1,000,000-sq ft of space for added production facilities and storage . . . March 1 is the date of occupancy for Garlinghouse, Fremon & Company's new headquarters in Los Angeles . . . L. B. Foster Co. has enlarged the stock of their Atlanta warehouse to facilitate immediate shipment of all products to any part of the Southeast . . . Chicago Bridge & Iron Company has opened enlarged sales offices in both San Francisco and Tulsa . . . Clark Equipment Company is expanding its new Construction Machinery Division plant in Benton Harbor, Mich., by 50%, as well as forming an international subsidiary, to be known as the Clark Equipment International, C. A., to consolidate the firm's export functions . . . Pioneer Engineering Works, Inc., has purchased the Minneapolis-Moline plant in Minneapolis as part of their $2,000,000 expansion program . . . **ADDITIONS TO LINES OF EQUIPMENT:** The Elgrader, motor grader attachment, has become the latest addition to the LeTourneau-Westinghouse line of earthmoving equipment. LeTourneau has agreed to purchase the entire output of Elgraders manufactured by the Reisser Corporation of Nebraska . . . Ottawa Steel, a division of the L. A. Young Spring & Wire Corp., has purchased the assets of the Tracto-Lift Company of Kansas City, Mo. The principal product manufactured by the newly-acquired company is a heavy-duty fork lift truck specially designed for moving bulky materials over rough or muddy terrain . . . **ELECTIONS:** The President of the Hyster Company, Ernest G. Swigert, was recently elected vice president of the National Association of Manufacturers. He becomes the first member from the Northwest to hold such a high post in the Association . . . Alfred X. Baxter, grandson of the founder of J. H. Baxter & Co., is the new executive vice president of the recently merged associated companies of J. H. Baxter & Co. . . . The American Cast Iron Pipe Company has elected A. J. Herrmann as their executive vice-president, and J. W. MacKay as vice-president, sales manager and secretary of the company . . .

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PROCEEDINGS AVAILABLE

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857. Some Aspects of Electronic Surveying in Offshore Areas, by G. A. Roussel. (SU) Electronic methods of surveying are finding increasing application for distance measurements and position fixing over water or inaccessible areas, particularly in the control of aerial photography and petroleum exploration operations. This paper describes various electronic methods with consideration of range, accuracy, and the operating problems associated with those methods.

858. Education of Civil Engineers: Need for Reconsideration, by L. E. Grinter. (BD) This paper reviews the recommendations of the ECPD Committee on Evaluation of Engineering Education, of which the author was chairman. The Committee was charged with determining the changes needed in engineering education (1) to keep pace with the rapid advances that are occurring in science and (2) to provide the next generation with leaders who will be able to apply new scientific discoveries in a creative manner.

859. Education of Civil Engineers: Training for Civil Engineering, by Benjamin A. Whisler. (BD) The present trend of engineering education is toward more technical courses in the basic sciences narrowly pointed toward careers in research and development in the manufacturing industries. Because most graduates still go to field or office positions closely associated with the construction industry, increased attention to basic sciences at the expense of engineering courses is inappropriate for undergraduates. Present curricula, kept up to date in course content, are still most appropriate for the training of prospective civil engineers.

860. Index to Proceedings, Volume 81 (1955), by the Board of Direction. (BD) A subject and author index has been prepared for all Proceedings Papers published in 1955; the numbers covered are 583 to 860. The subject headings used were taken from the names of the technical divisions of the Society; other headings were added when deemed necessary. By use of the author index, it is possible to trace all the discussion that a paper has received.

861. Rupture Surfaces in Sand under Oblique Loads, by Alfreds R. Jumikis. (SM) Some results obtained by the author from experimental research in psommamechanics made from 1939 to 1942 are reported. This research pertains to deformation in soil—the shape of the shearing or rupture surface in dry sand soil caused by an obliquely loaded foundation model. The phenomena involved are examined, and relevant mathematical expressions are given. It is shown that the shearing surfaces can be represented by particular types of logarithmic spirals, depending on the type of soil.

862. Basic Concepts on the Compaction of Soil, by C. Y. Li. (SM) The soil compaction process is considered on a rational basis, and basic concepts of the problems involved are presented. The law of conservation of energy is employed to interpret how energy is spent. The influence of various factors on the behavior of a soil mass during compaction is explained. The "stage compaction" concept is introduced, and the effect of gravel content on the compaction of fine soil fractions is presented.

863. Vibrations of Beams on Many Supports, by John W. Miles. (EM) The natural frequencies of a continuous beam resting on an arbitrary number of uniformly spaced supports are determined from a difference equation formulation. These frequencies fall in periodically spaced groups separated by spectral gaps of widths equal to approximately half the interval between the natural frequencies of a single beam on a square root frequency scale. Wave propagation along an infinite, periodically supported beam is discussed, and the phase and group velocities are evaluated as functions of frequency.

864. Control of Underseepage, Mississippi River Levees, St. Louis District, CE, by C. I. Mansur and R. I. Kaufman. (SM) The paper contains descriptions of the underseepage problem along Mississippi River levees and of procedures used to design seepage-control measures. Included are the investigations conducted, methods of seepage control, examples of design of control measures, and construction procedures used to install the control measures.

865. Structural Rigidity in Calculating Settlements, by Samuel Chamecki. (SM) A solution for the problem of interaction between a structure and its foundation, based on a system of simultaneous equations, is systematized by a set of objective operations. The method involves a simple system of successive corrections and is adaptable to any set of assumptions pertaining to the behavior of the soil.

866. Penetration Tests and Bearing Capacity of Cohesionless Soils, by G. G. Meyerhof. (SM) From a comparison between standard (dynamic) and static penetration resistances, a simple approximate correlation has been obtained for estimating the relative density and angle of internal friction of cohesionless soils. The proposed relationships are applied to determine the ultimate bearing capacity of footings and the

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point resistance and skin friction of piles, and the results are compared with some field loading tests on plates and piles.

867. Triaxial Shear Tests on Pervious Gravelly Soils, by Wesley G. Holtz and Harold J. Gibbs. (SM) This paper concerns a study of shear characteristics of pervious gravelly soils commonly used in earth embankments. Large-size triaxial equipment was used for tests providing information on the relations of shear and (1) density, (2) amount of gravel, (3) gradation, (4) particle size, and (5) particle shape.

868. Analysis of a Skew Diversion, by Wen-Hsiung Li. (HW) When a roadway intersects a relatively straight and stable stream at an acute angle, a common method of diversion involves a skew culvert with or without reduction of skew. When the culvert is put at a reduced skew, a ditch parallel to the roadway is often used. By the principles of engineering economics, the most economical location of skew culverts can be obtained, taking into account the relevant economic, hydraulic, and topographical factors. The result of this analysis shows the relative importance of these factors; it can be used as a guide to the economical design of skew diversions.

869. A Direct Method for Model Analysis, by Norbert E. Landdeck. (ST) A structural model cut from a flat sheet of plastic is combined with SR-4 resistance-type strain gages to offer a rapid solution of a statically indeterminate frame problem. The method of experimental stress analysis is described; it is considered practical for structural design problems involving short heavy members, frame members in which there are sudden changes in the depth of beams, or for the design of highly indeterminate structures.

870. On the Deflections of Bow Girders of Non-Circular Shapes, by Enrico Volterra. (EM) Deflections of bow girders of non-circular shapes built-in at both ends are studied. Solutions are given in explicit form for cases in which the central line of the curved beam is a cycloid, a catenary, or a parabola and the external forces are uniformly distributed along the length of the beam. Curves of the deflections, angles of twist, and bending and twisting moments are presented and compared with the corresponding values for the circular bow girder.

871. Control of Highway Access: Experiences in New York, by B. D. Tallamy. (HW) Experience with the New York Thruway has shown how limited-access highways foster safety, save travel time, reduce wear and tear on vehicles and drivers, relieve traffic on parallel roads, and promote astounding economic development of the area. More superhighways are needed across the nation; the immediate problem is how to finance them.

872. Control of Highway Access: Economic Effects of the Gulf Freeway, by D. C. Greer. (HW) This paper reviews some of the conclusions drawn from investigations of the economic effects of limited-access facilities on adjacent properties and presents a detailed account of the method of approach and conclusions of an economic survey of a freeway in Texas. The increase in land values of adjacent properties after a period of five years is evaluated.

873. Control of Highway Access: Experiences in Indiana, by Carl E. Vogelgesang. (HW) This paper covers the experience leading to the adoption and use of control of access in Indiana. There are described the measures taken in an effort to handle traffic satisfactorily on the state highway system through the construction of by-passes and dual lane pavements. High points of the legislative acts are quoted, and the benefits of controlled access are enumerated as well as the conclusions reached.

874. Control of Highway Access: Experiences in Los Angeles, by Hugo H. Winter. (HW) This paper examines briefly the history of the freeway system in the Los Angeles metropolitan area, the accomplishments in construction of the units of the system, the direct and indirect benefits already derived from the completed units, and the benefits to be obtained from a completed integrated system of freeways.

875. Control of Highway Access: User Benefits in California, by Ralph A. Moyer. (HW) An analysis is given of the user benefits resulting from the early completion of the freeways with full control of access in California. The analysis is an important consideration in determining the economic justification of the system. It is shown that estimated user benefits in the first ten years amounted to $1 billion, which is an amount greater than the total interest for thirty years on the investment, and over a thirty-year period the estimated benefits are almost $8 billion—more than double the total interest and principal required to finance the system.

876. Discussion of Proceedings Papers 604, 674, 818. (EM) D. Ross closure to 604. H. J. Cowan on, and B. Bresler and K. S. Pister closure to, 674. Corrections to 818.

877. Discussion of Proceedings Papers 500, 596, 783. (HW) No closure to 500. J. H. Moore closure to 596. G. H. Matthes, E. W. Lane, and C. F. Izzard and J. N. Bradley on 783.

878. Discussion of Proceedings Papers 588, 734, 762, 763, 764, 786, 809, 828. (ST) R. B. B. Moorman closure to 588. J. J. Polivka on 734. J. J. Polivka on 762. J. J. Polivka on 763. J. R. Benjamin on 764. E. G. Peterson, M. A. Roose, H. P. Budgen on 786. J. R. Benjamin on 809. G. V. Berg on 828.

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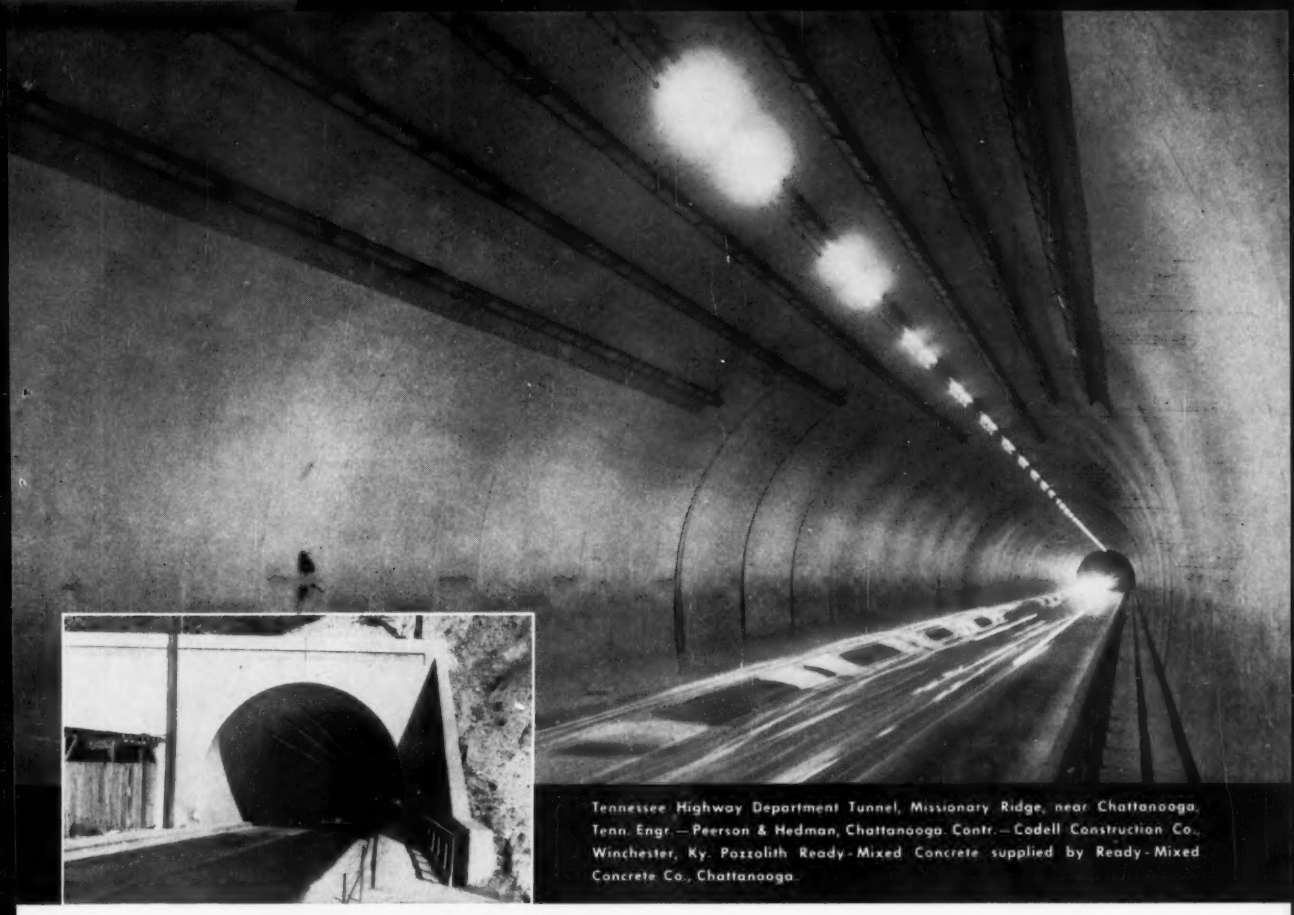

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